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This Week

Cars capable of 30 miles per gallon are in the near future. What will they be like? P. M. Heldt does a bit of looking forward on page 594.

Out of the Annual Tractor Meeting of the S.A.E. at Milwaukee came some enlightening data. There has been a lot of development in this field of which many seem to be unaware. It is well worth your time to turn to page 598.

Some letter writers have livened up the Forum this week on page 610.

Factory Schedules Raised For All of Second Quarter

Late Retail Peak Indicated as Sales Continue to Expand; Shops Busy Preparing for 1937 Models

With the automobile business approaching the seasonal peak, motor executives are firm in their opinion that a high level of activity will continue throughout the second quarter. Normally, the peak of retail sales is reached late in April or early in May and authorities are of the opinion that this pattern will hold for the current year. May is expected practically to parallel the big April volume with only a moderate decline in June.

So sharp and extensive was the seasonal expansion this year, and so strong the indicated demand for the near future, that most of the companies have been prompted to make upward revisions in their projections for every month of the current quarter. There is now little doubt but that the second quarter's output will exceed by a good margin that of the corresponding period last year when 1,264,232 vehicles were produced. April alone should account for 40 per cent of that number.

By the end of this month the industry will have turned out this year approximately 1,620,000 cars and trucks, or considerably more than were built in all of 1932, 80 per cent more than in the full year 1933, and 56 per cent more than in 1934. Since production of current models got under way at the start of the final quarter last year, the output of 1936 cars by the end of April will exceed 2,700,000 units or not much short of the entire 1934 production of 2,869,963 units.

Although production activity is at high pitch on present lines, manufacturers are turning their attention more and more to preparations for 1937 cars. Pattern, tool and die shops are beginning to get active. They report that considerable experimental work has come out of late and some production jobs are being let. Because of the strong demand for present models automobile manufacturers have been a little slow in starting their preparatory work, but tool and die shops expect to be quite active in another 30 days.

The peak of this business will probably not come until midsummer. Last year July was the peak month for employment of tool and die workers. The shops are expecting considerably more business on new models preparatory work than a year ago and it is believed there will be a strong demand for highly skilled craftsmen in these lines. All available pattern-makers are said to be employed already.

Domestic retail deliveries of the Buick Motor Co. during the first 10 days of April totaled 5568 units, the best for this period since 1928, and more than a three-to-one gain over the corresponding 1935 period. April deliveries are 72 per cent ahead of the first 10 days of March and 226 per cent over the corresponding period of February, indicating one of the most pronounced upturns in the history of the company.

Buick sales thus far this month bring the total since the first of the year to 34,318 units, more than double last year's business when 15,287 cars were delivered. Output reached a new peak, said W. F. Hufstader, general sales manager, when 4191 cars were built and shipped in the week ending April 10.

(Turn to page 586, please)

Kettering's 3rd Medal

Charles Kettering, vice-president and research director of General Motors Corporation, has been honored for the third time this year when he was named one of three men to receive the John Scott memorial award of a bronze medal and $1,000 for scientific research.

In February Kettering received the Washington award for 1935 given annually by five engineering groups for "accomplishments which preeminently promote the happiness, comfort and well being of humanity." Two weeks ago he was named as one of two men to receive Franklin medals for 1936, awarded by the Franklin Institute of Philadelphia for "significant and timely contributions to the science of automotive engineering."

FTC vs. Parts Groups

MEWA and NSPA Cited on Charges of "Unfair Competition"

Complaints alleging use of "unfair methods of competition in commerce" have been issued by the Federal Trade Commission against officers and members of the National Standard Parts Association and of the Motor and Equipment Wholesale Association. Similar complaints were issued at the same time against a number of automotive jobbers and manufacturers who are not connected with the above organizations.

The complaints are thus directed against practically the entire aftermarket industry, individuals and corporations engaged in the manufacture and distribution of automotive parts, tools, equipment, materials and accessories being cited.

The complaint against the M.E.W.A. charges the respondents with entering into agreements, combinations and conspiracies among themselves for elimination of price competition among jobbers, preventing the creation of new competition, and controlling parts and accessory prices.

This program, according to the complaint, was accomplished through agreement and concerted action in (1) use

(Turn to page 588, please)

SAE Production Meet

Numerous Papers and Factory Visits Held Interest of Engineers

By the time the book closed, over 300 production executives had registered for the S.A.E. Production Meeting held in Detroit this week. Production men flocked to this meeting from many manufacturing centers, such as Cleveland, Chicago, Racine, Milwaukee and several from far-away New York.

The high spot of the session was the banquet with the Detroit Section, S.A.E., acting as host and C. L. McCuen as principal speaker. A rather unusual touch was added to the pro-

(Turn to page 590, please)

Steel Now, Automotive Next?

Committee for Industrial Organization Believed to Be Planning Vertical Line-up of Detroit Plants

Concentrating on steel, the Committee for Industrial Organization, headed by John L. Lewis, president of the United Mine Workers of America, has made its first specific move to organize mass production industries. It proposes, so it has said, to unionize steel, automotive, rubber, textile and other large industries along vertical lines. Opposed by the American Federation of Labor, set up under a craft union policy, members of the C. I. O., with their unions, are nevertheless affiliated with the A. F. of L.

While a rift with the A. F. of L. continues to threaten, the C. I. O. campaign proposes industrial unionization in affiliation with the A. F. of L. William Green, president of the A. F. of L., together with craft union officials who are bitterly hostile to the C. I. O. campaign, has so far flatly refused to join with it and has said it threatens disruption of the parent body. The C. I. O., however, has insisted it will proceed with its campaign even if it means withdrawal from the A. F. of L.

The move to organize the steel industry took definite form by way of a direct approach to the Amalgamated Association of Iron, Steel and Tin Workers, headed by M. F. Tighe. In a letter to Mr. Tighe, John L. Lewis, president, and Charles P. Howard, secretary of the C. I. O., offer cooperation of the committee in a joint campaign with the Amalgamated Association to organize the steel industry. Mr. Tighe, according to the C. I. O., has assured the latter that its offer would be referred to the next meeting of the International Executive Board of the Amalgamated Association and would probably be acted upon at the Amalgamated Association convention in Canonsburg, Pa., April 28.

The C. I. O. offers to raise a fund of $500,000 to organize the steel industry. It also offers the "services of trained organizers" and makes the offer contingent on organization along industrial lines, with leadership of the drive "responsible and energetic." Establishment of a joint committee is proposed, made up of representatives of both the Amalgamated Association and the C. I. O., with other unions "willing to contribute to a joint campaign."

Meanwhile, Mr. Green, in a rival movement to organize the steel industry, has addressed a letter to all international unions asking financial support for an organization campaign in the steel industry. It is clear that the C. I. O. move has intensified the embarrassment of Mr. Green and A. F. of L. craft unionists, if it has not actually threatened their power. It is likewise plain that the Amalgamated Association will have to determine quickly whether it will continue to go along with the A. F. of L. or the C. I. O., for it is considered that the policies of the two groups are not reconcilable.

The belief is that the C. I. O. drive, in view of its great proportions, will be confined for the present to steel. Later, if conditions are considered favorable, it is expected to be broadened to include the automotive and other large industries now poorly organized.

The automotive industry has no representation in the way of company unions and its A. F. of L. unions are constantly at odds over questions of jurisdiction and related subjects. It therefore is held to be a less fruitful field at present for industrial unionization than steel.

Back of the entire move is seen the outstanding objective. This is the organization of an American Labor Party. Much talked of, and even attempted in the past, such a move is now more seriously contemplated than ever before. The organizers hope that the party will gather sufficient strength to organize nationally, pivoted on industrial unionization, and to have its own Presidential ticket in 1940 headed by Mr. Lewis. While in some quarters this development may be treated lightly, it is not so considered in important political circles of both the Democratic and Republican parties.

The attitude of organized labor toward setting up its own party was further reflected by W. Jett Lauck, consulting economist and labor adviser, in an address last Monday in Washington before the National Peace Conference.

Ray C. Ellis

who has been named general manager of General Motors' Delco Radio division at Kokomo, Ind.

Mr. Lauck declared that the hope of world peace lies in labor parties taking over the governments of Great Britain and the United States. He predicted that America would adopt a system of industrial democracy through a labor party to "supersede existing dictatorships."

Mr. Lauck insisted that the "old system of capitalism has failed in America" and said this fact was demonstrated in 1934 "when industrialists

Earnings Statements of Automotive Companies

	1935	1934
Automotive Gear Works, Inc.	$21,289*	$9,078
Checker Cab Mfg. Co.	2,397	354,883*
Whitman & Barnes, Inc.	181,784	51,055
Gulf Oil Corp.	10,551,720	2,811,183
Standard Oil Co. of Calif.	18,594,330	18,327,807

	1st Quarter 1936	1st Quarter 1935
Allen Industries, Inc.	$162,450	$122,285
Bohn Aluminum and Brass Corp.	335,129	554,613
Edward G. Budd Mfg. Co.	984,250†	151,589
Budd Wheel Co.	208,605	291,920
Campbell, Wyant & Cannon Foundry Co.	246,629	133,927
Caterpillar Tractor Co.	6,801,309	3,948,490
City Auto Stamping Co.	116,646	108,425
Cleveland Automatic Machine Co.	13,800*	97,769*
Detroit Gasket & Mfg. Co.	144,105	121,833
Doehler Die Casting Co.	209,622	172,721
Eaton Mfg. Co.	583,382	605,272
Ex-Cell-O Aircraft & Tool Corp.	2,221	93,112
Federal Mogul Corp.	94,252	2,435*
McCord Radiator & Mfg. Co.‡	123,121	42,893
Motor Products Corp.	274,475	292,285
Mullins Mfg. Co.‡	133,338	122,103
National Automotive Fibres, Inc.	207,914	263,880
L. A. Young Spring & Wire Corp.	427,248	520,932
Commercial Credit Co.	2,181,919	1,455,142
Atlantic Refining Co.	1,983,000§	129,000*
Shell Union Oil Corp.	1,681,984	1,121,040*
Tide Water Associated Oil Co.	2,707,702	1,220,991
Tide Water Oil Co.	1,865,396	571,007

* Net Loss. † Includes income of $638,000 from sale of British Pressed Steel Co. ‡ Before allowance for Federal taxes. § Preliminary.

rejected President Roosevelt's demand for further reduction of hours of labor." Mr. Lauck went on to say that capitalism "is now passing from the world scene and that the new industrial union leadership has recognized this condition and is standing for a public policy which includes a high degree of economic planning in which "production, prices and profits must inevitably be placed under government control."

New Reorganization Plan Submitted by Autocar Co.

An amended reorganization plan was mailed to stockholders of the Autocar Co. this week, subject to vote on April 29. Chief feature of the plan, drawn in accordance with the desires of stockholders, will be the issuance of one new $100 par value preferred share for each present $100 preferred share.

The new preferred stock will be entitled to cumulative dividends of $3 annually and in addition will participate as a class dollar for dollar with common stock as a class up to an additional $3 per year. It will also be convertible up to June 1, 1946, at the rate of five shares of common for each preferred share. Holders of the new shares will be entitled to vote for one director only, but in other matters will vote equally with the common.

New debentures, to be purchased by the Phoenix Securities Corp., are to be dated May 1, 1936, instead of Jan. 1, 1936, and will mature May 1, 1946.

GEORGE E. OLMSTEAD, of New Haven, who has been operating as a manufacturer's agent in Connecticut, has joined the staff of the Morse Chain Co.'s New York office, and will continue to cover the state of Connecticut.

E. H. JESSOP, formerly with the Morse Chain Co. at Ithaca, N. Y., is now with the Tranter Mfg. Co., of Pittsburgh, Pa., in charge of their Morse Chain sales.

A. G. PHELPS has been promoted sales manager of the Delco-Remy Corp. to succeed O. Lee Harrison, who has retired.

J. H. BOLLES, who has been connected with the sales department of Delco-Remy for a number of years, has been named assistant sales manager in charge of the company's Detroit office.

H. SCHRECK has resigned his position with Ingersoll-Rand, at Painted Post, N. Y., and is now assistant chief engineer in charge of design with Fairbanks, Morse & Co., Beloit, Wis.

WALTER E. HAWKINSON has been elected treasurer of the Allis-Chalmers Mfg. Co. to fill the vacancy caused by the death of Raymond Dill. Mr. Hawkinson was assistant manager of the tractor division, and had previously served 15 years in the treasurer's department.

Ghost of a 1907 Steamer

May Cost White Motor Co. $10,000 as Result Of Ancient Canadian Litigation

The failure of the White Motor Co. to oppose a judgment by default, rendering them liable to $10,000 damages, within the legal time of 15 days, resulted in the company being ordered by the Court of Appeals on April 11, to pay the Dominion Motor Car Co., a subsidiary of Henry Morgan & Co., Ltd., Montreal, the $10,000 for which the latter firm had obtained judgment in 1910, with interest since that date, the latter now amounting to $13,500.

The damage claim arose out of the appointment in 1907 of the Dominion Motor Car Co. as agents for the White steam car. One was sold to a man at Thetford Mines, Que., but it took three weeks to make the journey, there being frequent breakdowns, which involved bringing mechanics from the factory, to which the machine was finally sent back. The White company refused to accept the car and returned it to Montreal, and it was eventually sold.

The local company claimed the money they had expended on repairs, as well as the value of the machine, and damages for loss of business, claiming that the failure of the car to operate properly, at a time when automobiles were somewhat of a curiosity on the highways, attracted such attention that further sales were impossible, and the company was forced out of business. Action for $10,000 was taken, the attorneys for the White company refused to accept service, which was made through the newspapers, and in 1910, judgment by default was given.

Since the White company had no assets in Canada, the judgment could not be executed, but in 1931 they opened a branch in Canada, and copy of the judgment was filed with them. They entered opposition, and Mr. Justice P. Demers in 1934 heard evidence and reduced the amount of damages to $3,450. This was the judgment in appeal, the Dominion Motor Car Co. claiming that opposition had not been entered with due diligence. The Court of Appeals maintained this, pointing out that the White Motor Co. had not entered opposition until 55 days after service of the judgment and that as such opposition should have been made within 15 days, they were too late and the original judgment for $10,000 with both interest and costs must be maintained.

1000-HP. Pratt & Whitney Wasps Ordered by United

The recent order from United Air Lines for 26 Pratt & Whitney Twin Wasp engines has created renewed interest in these 1000-hp. twin bank, 14-cylinder engines. Similar to those now in serivce on the Trans-Pacific clipper ships, the new motors will power United's new 25-passenger Douglas DC-3 transports.

In addition to the tremendous power output, developing 1150 hp. at full throttle, and weighing but 1250 lb., the new engines combine many unusual features. The automatic mixture control, which provides a manual setting for take-off, climbing and cruising mixtures, is otherwise entirely automatic in operation. Valve lubrication is completely automatic, and lengthens time between service operations to a minimum of 80 hours. Deep cooling fins are supplemented by pressure baffles which direct air flow throughout the entire engine.

A. J. Scaife Joins Autocar; Will Be Bachman Associate

Announcement was made this week by the Autocar Co., Ardmore, Pa., that A. J. Scaife has joined the company's engineering research staff as associate to B. B. Bachman, vice-president in charge of engineering.

For 36 years Mr. Scaife has been connected with the White Motor Co., serving successively as tool maker, tester, experimental engineer and consulting field engineer. Recently he was on the Pacific coast as a member of the White Company's national sales department.

A member of the Society of Automotive Engineers since 1910, Mr. Scaife was president of the Society in 1932 and has participated in many of its activities, including service on the Ordnance Advisory Committee, several standards committees and the Motor Coach and Truck Committee.

A. J. Scaife

Business in Brief

Written by the Guaranty Trust Co., New York, exclusively for AUTOMOTIVE INDUSTRIES

General business activity last week advanced sharply and is reported as being at the highest level in six years. There was a further expansion in wholesale and retail business. The upturn in retail trade is being led by the department stores in the East, reversing the trend in the last two years. Department store sales for the country as a whole during the first ten days in April were 20 per cent above those in the corresponding period last year.

Car Loadings Continue to Gain

Railway freight loadings during the week ended April 11 amounted to 622,138 cars, which marks a gain of 8271 cars above those in the preceding week, a rise of 35,570 cars above those a year ago, and an increase of 42,157 cars above those two years ago.

Food Prices Easier

Retail food costs declined by 0.7 per cent during the two weeks ended March 24, according to the Bureau of Labor Statistics. The current index stands at 79.0 based on the 1923-25 average as 100, as against 79.5 two weeks earlier and 79.8 a year earlier.

Electricity Up 12 Per Cent

Production of electricity by the electric light and power industry in the United States during the week ended April 11 was 12.1 per cent above that in the corresponding period last year.

Corporate Profits Highest Since 1930

According to the Federal Reserve Bank of New York, aggregate profits of 700 leading business corporations during 1935 were 48 per cent above those in 1934 and were the largest for any year since 1930.

Lumber Output Off

Production of lumber during the week ended April 4 was 59 per cent of the 1929 weekly average and was 6 per cent below that in the preceding week. Shipments and new business were 4 and 3 per cent, respectively, below the levels reported for the preceding week.

Fisher's Index

Professor Fisher's index of wholesale commodity prices during the week ended April 18 stood at 82.6, as against 82.5 for both the week and two weeks before.

Federal Reserve Statement

The consolidated statement of the Federal Reserve banks for the week ended April 15 showed no changes in holdings of discounted bills, of bills bought in the open market, and of government securities. Money in circulation declined $29,000,000, and the monetary gold stock increased $10,000,000.

Factory Schedules Raised for All of Second Quarter

(Continued from page 583)

Studebaker sales of passenger cars and trucks in the first 10 days of April increased 56 per cent over the corresponding period of 1935, according to Paul G. Hoffman, president. The company's sales were as follows: April 1 to 10, 1936, 3088 units; April 1 to 10, 1935, 1981 units; March 1 to 10, 1936, 2206 units.

Delivery of 85 new Studebaker "cab-forward" trucks to the Keeshin Motor Express Co., Inc., of Chicago, was made this week.

Current retail sales of the Chrysler Corp. are running substantially in excess of sales at the same time last year, K. T. Keller, president of the corporation, told stockholders at their annual meeting. Employment is today about 62,000 in the plants of the Chrysler Corp., and hourly rates of pay are the highest in the history of the corporation, exceeding even those paid in 1929. Introduction of new models in the fall of last year instead of January, as well as improvement in manufacturing methods, is resulting in a substantial increase in the continuity of employment and consequently in real wages of the employees, according to Mr. Keller.

Automotive Industry Failures Only 19 Last Year, a New Low

Continuing the five-year downtrend, only 19 failures were registered for manufacturers of automobiles, automobile supplies and accessories in 1935, according to figures compiled by Dun & Bradstreet, Inc. This was the smallest number on record for this division of the industry. The involved liabilities also made a new low at $684,733, a drop of 79.3 per cent from 1934.

For wholesalers and retailers of automobiles, automobile supplies and accessories, however, failures increased in 1935, rising from 210 in 1934 to 251, a gain of 19.5 per cent. In spite of the larger number of failures in this group, the 1935 defaulted indebtedness reached a new low, $3,908,441, a decline of 23.3 per cent from the 1934 amount of $5,098,997.

The complete insolvency record of the automobile industry since 1930, including January and February of this year, follows:

Manufacturers

(Automobiles, Automobile Supplies and Accessories)

Year	Number	Liabilities
1930	196	$5,410,562
1931	114	2,832,260
1932	115	10,905,517
1933	34	972,514
1934	24	3,307,455
1935	19	684,733
1936*	2	82,151

Wholesalers and Retailers

(Automobiles, Automobile Supplies and Accessories)

Year	Number	Liabilities
1930	1,155	$23,733,170
1931	824	15,895,764
1932	872	27,441,884
1933	357	9,509,054
1934	210	5,098,997
1935	251	3,908,441
1936*	50	770,455

* January and February.

March Rubber Consumption Up; Stocks 21% Below Last Year

March consumption of crude rubber by manufacturers in the United States totaled 42,703 long tons, compared with 36,746 in February and 42,620 in March, 1935, according to estimates of the Rubber Manufacturing Association.

Imports for March were 37,451 tons, while stocks on March 31 stood at 267,519, compared with 338,700 a year ago. Rubber afloat to the United States amounted to 58,935 on the same date.

March consumption of reclaimed rubber totaled 8767 tons and production reached 10,712 tons.

40 Years Ago

with the ancestors of AUTOMOTIVE INDUSTRIES

Foreign Notes

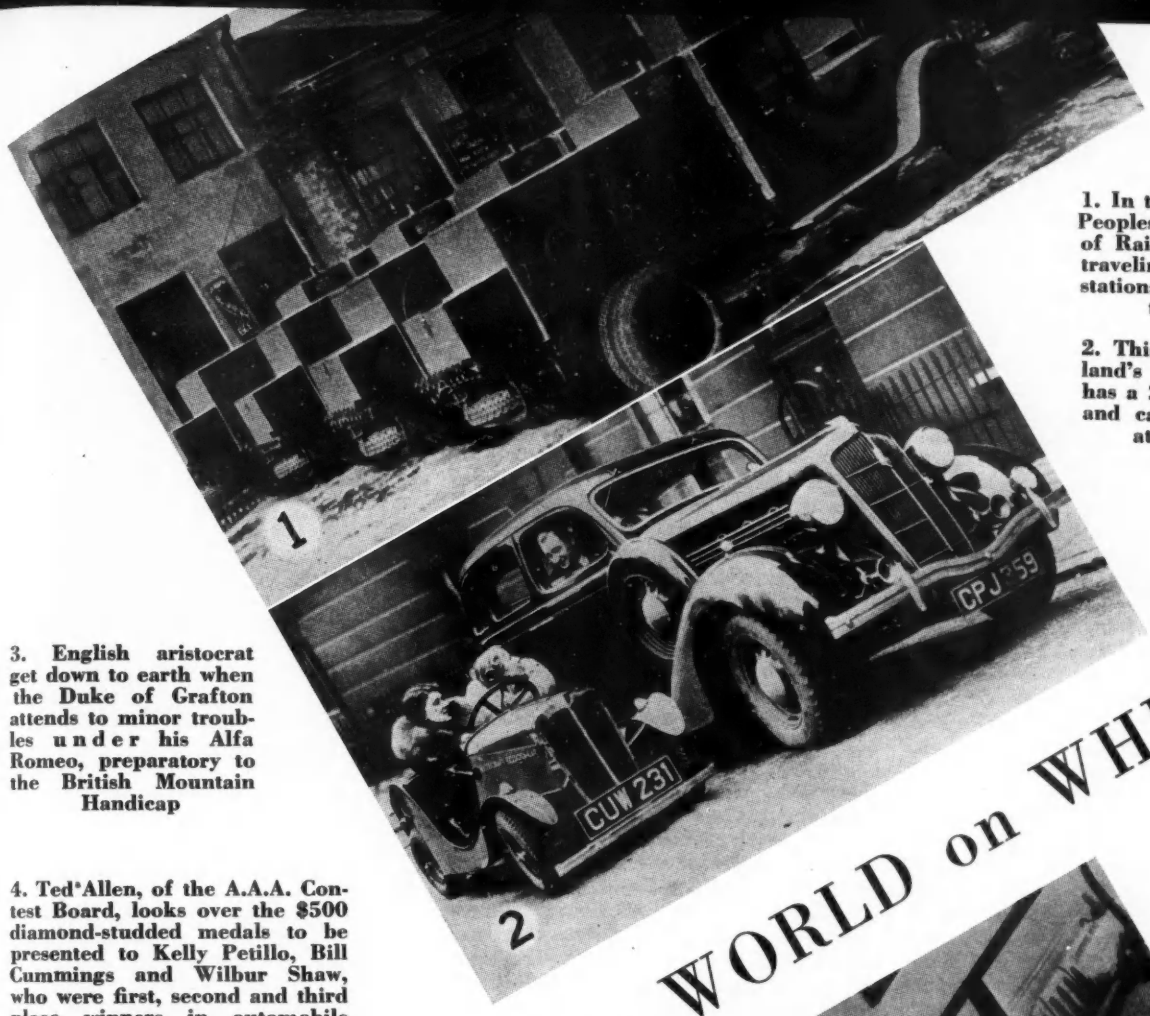
The amount subscribed for the Paris-Marseilles race already exceeds 40,000 francs, of which James Gordon Bennett gives 10,000.

The Compagnie Générale des Omnibus of Paris has ordered a Serpollet steam omnibus, which will be put into service on its lines.

A writer in a recent issue of the *Journal des Industriels* of Paris tells us that, thanks to the visit of M. Roget to these shores last summer, 25 motor delivery wagons are now to be seen daily in the streets of New York. Would this were true.

—From *The Horseless Age*, April, 1896.

The WORLD on WHEELS



1. In the U.S.S.R. the Peoples Commissarist of Railways has built traveling compressor stations for construction work

2. This Scoota, England's cheapest car, has a 2½ hp. engine, and carries 2 people at 45 m.p.h.

3. English aristocrat get down to earth when the Duke of Grafton attends to minor troubles under his Alfa Romeo, preparatory to the British Mountain Handicap

4. Ted Allen, of the A.A.A. Contest Board, looks over the $500 diamond-studded medals to be presented to Kelly Petillo, Bill Cummings and Wilbur Shaw, who were first, second and third place winners in automobile racing last year

5. Winter training for Russia's Red Army includes this ski practice, towed by powerful tank

Acme, Keystone, Soyuz photo, and Underwood & Underwood photos.

UAW Prepares for Convention

Split Between Dillon and Other Leaders Expected to Result in Hot Fight for Presidency

Preliminaries got under way Thursday for the international convention of the United Automobile Workers Union, A. F. of L. affiliate, formally opening at South Bend, Monday, April 27. The committee on credentials and rules went into session Thursday to act on the seating of delegates. The executive board was to meet Friday to consider policies and determine recommendations to be made to the convention.

A spirited contest for leadership is expected in view of the rift that developed early in the year between president F. J. Dillon and other members of the board. Leaders in the opposition to Dillon's control were Homer Martin, executive vice-president and Ed Hall, secretary-treasurer. The temporary truce effected pending the coming election of international officers undoubtedly will be lifted on the floor of the convention and the battle for control renewed. Secret caucuses are reported to have been held by various factions.

Three candidates for the presidency are understood to be in the field, each with a substantial following. These are: W. J. Mortimer, of White Truck, Cleveland; Russell Merrill, of Studebaker, South Bend; and Homer Martin, of Kansas City. Dillon has said he is not a candidate for reelection but many believe that when the smoke of battle has cleared this veteran labor leader will retain his post.

Dillon materially strengthened his position when recently he sent all delegates a formal report of his activities as president. His accounting of his office is said to have made a very favorable impression on the delegates. Mortimer, an able speaker, is strong in Cleveland. Merrill, who is ill as the result of an automobile accident, has the support of the Studebaker local, largest in the union. Martin is said to have lost some of his earlier strength but has a big Toledo following.

The Mechanics Educational Society has just completed balloting for new officers in a hotly contested election, the results of which will not be known until the votes being reported by the various locals are counted in Detroit Saturday. Mathew Smith, general secretary, has been faced with serious opposition for the first time in three years, with James Murdock, acting president of the Tool and Die Makers Union, as his opponent for reelection. George Becker of Toledo was unopposed for the presidency.

F.T.C. vs. Parts Groups

(Continued from page 583)

of uniform and substantially identical resale prices fixed by manufacturers; (2) threats of boycott and actual boycott against manufacturers not complying with the program; (3) monopoly in the distribution of replacement parts, accessories and shop equipment through "legitimate jobbers"; (4) strict enforcement of rules for jobbers recognized as "legitimate," and (5) establishment of jobbing points, "ethical merchandising," or "clean merchandising" policies for promotion of the respondent's program, and holding local and regional group meetings at national shows and elsewhere, of which only meager and incomplete records have been kept so as to avoid giving evidence of agreements and to minimize detection.

The complaint charges that association members and non-member jobbers cooperating with them have both threatened to boycott, and boycottted, the following groups: (1) parts and accessory manufacturers failing to fix uniform and substantially identical resale prices for their products and discounts to jobbers; (2) manufacturers who refused to stop selling to jobbers not classed as "legitimate"; (3) manufacturers selling at discounts greater than those allowed by them to association members; (4) manufacturers who would not stop selling even at the currently prevailing resale prices to jobbers seeking to establish themselves in a territory in competition with association members already established there; (5) manufacturers who would refrain from selling at jobbers' discounts to buyers classed by the association as retailers and not jobbers; and (6) manufacturers who would not cease selling to jobbers who would not maintain the manufacturers' resale prices in their retail sales.

These practices are alleged to have had a tendency to prevent manufacturers from competing among themselves as to prices and from selecting jobbing distributors who would compete as to price, as well as to constrain all jobbers to sell their products at uniform prices fixed by the manufacturers, all in violation of Section 5 of the Federal Trade Commission Act.

Other effects of the respondents' program are alleged to have been the obstruction and prevention of the establishment of new jobbers in certain territories and the suppression of all price competition in the jobbing of products in those territories, particularly among association members.

The complaint against the N.S.P.A. makes substantially the same charges of price fixing monopoly, or attempted monopoly of distribution; elimination of competition; and limitation of points of distribution.

The commission has fixed May 22 as the date for hearings on both complaints.

The number of F.T.C. complaints against "unfair competition" has been increasing continually since the abolition of the NRA. Other lines of business as well as the automotive parts industry have been affected. Most of these complaints have been against practices which were legal under NRA but have since been outlawed. The chief difference between the present complaints and former ones is that those just issued contain a charge of boycotting while the others did not.

Automotive Tests at Aberdeen

Major F. G. Atwood Describes Unusual Features of Army's Proving Ground Equipment

A giant field dynanometer and an automatic time-distance recorder proved most interesting features of an illustrated lecture given on April 22 before the Philadelphia section of the American Society of Military Engineers, by Major F. J. Atwood, chief of the automotive testing division of the army ordnance proving ground at Aberdeen.

A drawbar connected to a hydraulic recording system and mounted on the front of a large truck forms the basis of the unusual field dynamometer. The drawbar pull of any vehicle being tested can be measured by the device, and at the same time hydraulic pumps, geared to the four rear driving wheels and controlled by valves, permit the entire equipment to roll at predetermined speeds to accommodate engine performance throughout its entire speed range. Using the dynamometer itself as the pulling agent allows complete tests for horsepower required to move a given vehicle under any condition.

The automatic time-distance recorder is available for many tests such as the plotting of acceleration, deceleration or coasting curves, and is also capable of plotting horsepower performance and drawbar pull at varying engine speeds.

The power consumed in bending various types of tracks is accurately measured at another unique station, while other apparatus determines center of gravity, load distribution, limits of visibility, dead area of fire, suspension flexibility, pitch, roll and vertical acceleration, and many other features.

Vertical walls and open trenches are used to test track equipment, while all vehicles are submitted to the more common tests which include a concrete water-trough which also serves as mud retainer, a cobble-stone bowl, a sand course, hill climbs varying from five to 60 per cent and a 50-mile cross-country run.

Charles A. Chayne

Chayne Succeeds Bower As Buick Chief Engineer

Appointment of Charles A. Chayne, former assistant chief engineer, to the post of chief engineer of the Buick Motor Co., was announced today by Harlow H. Curtice, Buick president and general manager. Mr. Chayne will succeed F. A. Bower who has been granted an indefinite leave of absence because of ill health.

Coming to Buick in January, 1930, as motor engineer, Mr. Chayne was appointed assistant chief engineer in November, 1933.

Following his graduation from the Massachusetts Institute of Technology in 1919 with a degree in Mechanical Engineering, he taught automotive engineering at the Institute until 1926. During 1927 he spent nine months as experimental engineer with the Lycoming Manufacturing Co. at Williamsport, Pa., manufacturers of automobile engines, after which he joined the Marmon Motor Car Co. at Indianapolis as engine designer. He is a memebr of the S.A.E.

Automotive Cooperation Asked By Steelman in Bethleham Talk

A plea for greater cooperation between automotive and steel engineers was made by W. R. Shimer of the Bethlehem Steel Corp., in a talk before a joint meeting in Bethlehem on April 17 of the Philadelphia section of the S.A.E. and other engineering organizations.

New steels, new draws, new forms, always bring with them new problems, Mr. Shimer pointed out, yet steel companies are seldom notified of new demands until just before the new models go into production. More time for experimentation in the mill would mean less time lost in the field.

Predicting the use of even lighter gage steel on next year's models, with even deeper draws and elongations, the speaker warned that as tensile strength increases, bringing with it lower weight, ductility and forming strength decrease.

But much praise was forthcoming for the automotive engineers who by increasing demands and scientific cooperation had kept steel men "on the ball." The recent progress in steel was brought out by the fact that now only two draws and no annealing were required for automotive sheets, where formerly seven draws plus annealing were used. All this has come in spite of the fact that modern finishes are so transparent that even the slightest blemish on the steel may mar the final appearance.

Other papers of the evening were presented by Henry Wysor, "Automotive Steels and the Engineer," and H. J. Bowles, "Progress of Electric Welding." Both men were also of the Bethlehem Steel Corp.

Power Engineers Discuss Diesels

Builders and Refiners Should Cooperate on Fuel Research; Durability Called Their Chief Asset

Engineers who attended the Midwest Power Engineering Conference and Exposition in Chicago this week devoted much time to a discussion of problems concerning Diesel powered machines.

Present-day uses of Diesel powered machines and machinery are still limited, and they will be for some time to come, declared G. E. Spain, Caterpillar Tractor Co. of Peoria, Ill. Mr. Spain told his audience that 45 per cent of Diesel horsepower sold in the last year were of the heavy duty, medium speed, portable types for construction and contracting uses.

"Last year approximately 1,200,000 Diesel horsepower was sold," said Mr. Spain, "which was 60 per cent more than the sales in 1934 and more than double the sales during any two preceding years.

"The durability of Diesel powered machines is one of their most important essentials," he said. "Most of their work is done under the worst possible conditions—where dust and water are frequent, and they are run at high engine speed while idling and sudden load strains."

Mr. Spain also declared that increasing demand for cheaper power has caused manufacturers of Diesel engines to turn their attention to lines tending to bring about finer engineering of construction. He said the Diesel engine could not expect a universal demand comparable with gasoline engines until Diesel engineers had reduced their costs to a common level with gasoline type engines.

Reading a paper on Diesel fuels, T. M. Robie, Fairbanks, Morse & Co., stated that the original conception that a Diesel fuel was "anything which would flow through the fuel pipes" is still confusing many. "Developments in smaller cylinder bores and increased engine speeds have had marked effects on Diesel fuel requirements," he said.

"Probably the one thing which has caused confusion in regard to Diesel engine fuels has been the fact that it is only comparatively recent that Diesel engine manufacturers have given any thoughts toward standardization of their product," said Mr. Robie. "Permanent committees of the D.E.M.A., S.A.E., A.S.M.E. and A.S.T.M. have worked in close harmony in conducting studies, but the work of these committees is far from being completed. In fact, it has only been in the last two years that any real progress has been made. Several of the larger oil companies are cooperating toward the end that a clearer understanding of the thing may be had."

Mr. Robie said "the suitability of Diesel fuels concerns the engine builder equally with the refiner. The designer must perfect his engine so that it will properly digest fuels which may be made by the refiner, who in his turn must consider the all-important essentials of availability, price and uniformity."

Doman-Marks Engine Co. Buys Plant at Syracuse

The opening of a plant at Syracuse, N. Y., by the Doman-Marks Engine Co., Inc., to accommodate the increasing demand for air-cooled engines for industrial and truck use, was announced last week by E. S. Marks, president. Facilities involve 20,000 sq. ft. in the single-story factory used formerly by the Thorne Machine Co. Installation of machinery and equipment will be completed and operations commenced by April 30.

Young Spring & Wire Buys New Plant in Los Angeles

L. A. Young Spring & Wire Corp. has acquired a new plant in Los Angeles which will soon be placed in operation, L. A. Young, president, told stockholders at the annual meeting. The new plant is designed particularly to handle cushion spring business for automobile assembly plants in the Los Angeles area but will also make other products.

De Soto assembles radiator shells on a "merry-go-round" conveyor system. Each of the 16 little trucks carries its own assortment of bolts, nuts and other parts so that after a round trip between the two lines of workmen the shell is completed.

SAE Production Meet

(Continued from page 583)

ceedings by the attendance of five Production Activity vice-presidents: K. L. Herrmann, present vice-president, and four former vice-presidents, each of whom served as chairman of a technical session.

K. L. Herrmann was chairman of the opening session on Tuesday, devoted to foundry procedure and machining of cast crankshafts and camshafts. W. F. Pioch, of Ford Motor Co., was complimented for his presentation of the "Casting and Machining of the Ford V-8 Crankshaft," in which were disclosed all the significant details of manufacturing procedure.

Some of the comments on machine shop procedure are of particular interest. For example, no straightening is required either before or after machining. Another point is that machinability is a rather big problem, so much so that the customary tool materials do not give the life that might be expected in general practice. In fact, it has been necessary to slow down operations to increase tool life. In turning, speed has been reduced 55 per cent, while feed has been maintained as high as possible without chatter. In drilling or tapping, spindle speeds have been reduced 40 per cent. For grinding, they have found it necessary to use wheels one grade softer, with same grain as for forged shafts.

D. J. Vail, Campbell, Wyant and Cannon Foundry Co., reviewed the cast camshaft in his paper, "Development of Proferall Cast Camshafts." Since 1932, his company has produced almost 3,000,000 of these camshafts, the largest volume going to Hudson. Although the cast camshaft was started many years ago, serious work was not begun until about 1930 and the development really lagged until the electric furnace became a commercial practicability. Although each production shaft is tested for impact, the total rejection loss for any reason ran about 0.6 per cent during 1935. Incidentally, careful study of all broken shafts indicates that surface quality inspection will detect any possible internal flaws, thus making x-ray examination absolutely unnecessary. The paper was supplemented by notes on machining the Hudson 8 shaft, contributed by Hudson. These notes indicate that the original machining procedure has been greatly simplified by virtue of improvement in casting technique, the most important change being the elimination of chilled sections in the mold. Hudson uses carboloy and J-metal tooling on all operations of turning and facing.

Those who may question the scope of the crankshaft development will find the answer in the paper by A. K. Antonsen of Fairbanks Morse, "Machining of Large Diesel Crankshafts," in which he describes the machining of what is probably the largest crankshaft of its type in production today. It is an eight-throw shaft with eight inch journals, weighing 1300 lb. in the rough and machining to 1050 lb. The reason for adopting the cast shaft is that shafts of this size have to be forged by hand and the finished forged shaft would weigh at least 300 lb. more.

R. E. W. Harrison, vice-president of the Chambersburg Engineering Co., submitted a written discussion aimed at both the Pioch and Vail papers, in which he indicated that the manufacturing economy comparisons between the cast and forged shafts would be of entirely different character if modern forging equipment were to be used. In fact, he implied that modern forging methods might swing the scale to forged shafts if economy is the determining factor.

Tuesday evening, W. H. McCoy of General Motors Research, was chairman of the balancing session at which papers were presented by S. T. Foresman of Chrysler, "The Influence of Balancing on Today's Automobile," E. J. Wolff and Lawrence F. Hope, of General Motors Research, "Production Balancing Practice," and B. E. Ohlson of Tinius Olsen, on the "Olsen Method of Balancing." The latter paper discussed the operation of the Olsen-Lundgren crank balancing machine, a static balancing machine, and a new type of static balancing machine which will determine the amount of unbalance by means of centrifugal forces. This machine has a vibrating cradle supported on flexible springs in the vertical position. It may be used for balancing clutches, flywheels and fan assemblies.

Wednesday morning, the party left for a tour of the Great Lakes Steel plant and saw the impressive newly installed equipment for rolling 79-in. wide sheets for auto bodies. A technical session held at the plant under the leadership of V. P. Rumely of Hudson was featured by a paper by E. L. Wetstein of Great Lakes entitled, "Steel for the Automotive Industry."

F. W. Cederleaf, Ex-Cell-O Aircraft and Tool Corp., was chairman of the Wednesday evening session on machining at which papers were read by R. N. Brown, master mechanic of Packard, and J. P. Wells of Pontiac Motor Co. R. N. Brown devoted his discussion to the "tooling of the Packard 120 Cylinder Block." He paid a tribute to the Ingersoll Milling Machine Co. for the development of the line of Power-Pack machines which were designed, tooled and installed for Packard by this organization. Originally the whole line was set up in the Ingersoll plant and tested on about 400 blocks before shipping to Detroit. The machine line includes 33 new machines, 1037 special jigs, fixtures, gages, etc., and 323 standard tools. One of the unusual features of this contract is the fact that Ingersoll not only prepared the sequence of operations and plant layout but also made miniature models of all the equipment and set it up in Detroit to show how the line would look when installed.

"Modern Machine Cutting Tool Requirements," by J. P. Wells, deals chiefly with the use of cemented carbide tools in the automotive industry. However, the author also included comment on the increasing use of J-metal for many important operations. By means of slides the author showed examples of

milling cutters, boring cutters, multiple-blade cutters, reamers, piston grooving tools, etc. Among the materials which are being machined with cemented-carbides, Mr. Wells listed cast-iron, bronze, aluminum, malleable die castings, etc. He noted that a number of successful steel applications are in use but added that these should be considered as exceptions rather than a rule.

Thursday morning had a treat in store for the production men in the form of a plant visit to the Aluminum Co. of America and from there the party adjourned to the Plymouth Motors cafeteria. This was the scene of a technical session on aluminum piston manufacture under the chairmanship of D. W. Wallace, Chrysler vice-president. The paper, entitled "Manufacture of Elliptical Skirted Pistons," was read by E. S. Chapman, general works manager, Plymouth Motor Corp. An abstract of Mr. Chapman's paper will be published in AUTOMOTIVE INDUSTRIES in an early issue.

Three Colorado Bus Lines Join New Trailways System

Three Colorado bus lines are reported to have joined the new National Trailways System, which was organized recently with three railroad-owned bus systems as its nucleus. They are the Denver, Colorado Springs, Pueblo Motor Ways, the Denver-Salt Lake & Pacific Stages, and the Rio Grande Motor Ways. All have their offices in Denver. At a meeting of the executive board of National Trailways this weekend in Wichita, Kan., several other lines will make application for membership.

GM Buys Radio Plant From Crosley Corp.

Purchase of the factory of the Kokomo Division of the Crosley Radio Corp. at Kokomo, Ind., by General Motors Corp., effective May 1, was announced last week by Alfred P. Sloan, Jr., president of General Motors.

The Kokomo plant will be known as the Delco Radio Division and will operate as subsidiary of the Delco-Remy Division. It will manufacture automobile radios for General Motors cars. The corporation will continue, however, to purchase a considerable portion of its automobile radio requirements from outside radio manufacturers.

Ray C. Ellis, now a member of the engineering staff of General Motors, will be general manager of the new division.

Output of the new division will be sold to the various automobile manufacturing divisions of General Motors for installation as initial equipment of new cars at the factory and to General Motors dealers through the present established channels. A rapidly increasing number of cars sold by General Motors dealers throughout the country are being initially equipped with radios.

Total March Production Up 47%

Output Was Below 1935 Level, Though Trucks Show Strong Gain for March and First Quarter

Total vehicle production in the United States and Canada for March totaled 442,545 units, an increase of 47 per cent over the previous month. In spite of the tremendous gains, the total still fell short of the 451,768 units produced in March, 1935.

Total truck production, totaling 82,890 units, showed substantial gains over both the February, 1936, and March, 1935, figures, and while passenger car production for the first three months this year increased 1142 units over the 1935 figure, truck output showed a gain of 17,248 units for the same period.

Canadian production for the first quarter was nearly 20 per cent below the corresponding period last year.

The table below, based on figures released by the Bureau of the Census, Department of Commerce, shows comparative production figures.

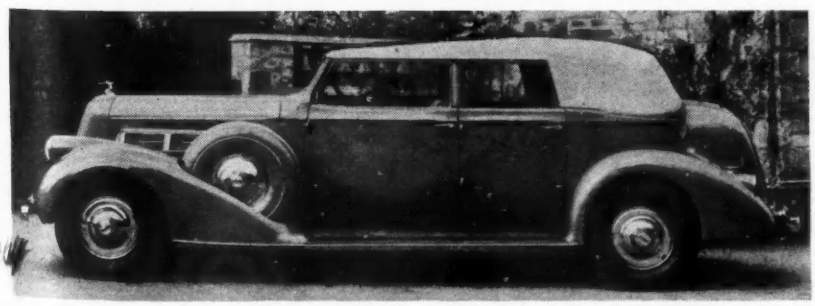
Passenger Car and Truck Production—U. S. and Canada

	March, 1936	February, 1936	March, 1935	First Three Months 1936	First Three Months 1935
Passenger Cars—U. S. and Canada:					
Domestic Market—U. S.	323,038	204,681	335,674	808,687	803,524
Foreign Market—U. S.	22,129	21,771	26,142	62,858	63,148
Canada	14,488	10,853	18,179	36,602	40,333
Total	359,655	237,305	379,995	908,147	907,005
Trucks—U. S. and Canada:					
Domestic Market—U. S.	65,496	51,204	56,594	171,331	159,261
Foreign Market—U. S.	13,908	13,308	11,383	39,911	32,312
Canada	3,486	2,415	3,796	7,942	10,363
Total	82,890	66,927	71,773	219,184	201,936
Total—Domestic Market—U. S.	388,534	255,885	392,268	980,018	962,785
Total—Foreign Market—U. S.	36,037	35,079	37,525	102,769	95,460
Total—Canada	17,974	13,268	21,975	44,544	50,696
Total Cars and Trucks—U. S. and and Canada	442,545	304,232	451,768	1,127,331	1,108,941

Federal Gets Government Order for 278 War Trucks

Federal Motor Truck Co. has received an order from the government for 278 trucks with cab, cargo bodies and special War Department equipment. The order amounts to $350,000 and brings the amount of government business received so far this year by Federal to 491 trucks valued to $650,000.

The company reports that March orders from all sources were approximately double the volume of March last year and the largest since March, 1929. First quarter business showed a gain of 36 per cent over a year ago and production schedules have been speeded up extensively. First quarter export business was up 40.3 per cent over corresponding quarter last year.



Pierce-Arrow's convertible sedan-phaeton is now in production. It is available on either the DeLuxe 8 or the Salon 12-cylinder chassis of 144 in. wheelbase. A secondary windscreen, mounted in a well at the rear of the front seat is optional

Custom Station Wagon Produced by Terraplane

Shipments of the new Terraplane custom station wagon have just been started from the Hudson factory, Detroit, W. R. Tracy, vice-president in charge of sales, announced this week. The station wagon seats eight passengers and has ample room for luggage. The end gate opens downward, providing space for additonal luggage. The second compartment doors and rear side windows are provided with curtains, which slide up around the top, while the rear curtain above the end gate rolls up and secures with buttons.

SAE Production Meet

(*Continued from page 591*)

In addressing the banquet of the Production Meeting, C. L. McCuen, Olds president, dwelt on the fact that the automobile industry has led the procession out of the depression and that its leadership is dependent upon ability of cooperative effort on the part of management, engineers and production men, all striving for a common goal. This cooperation has made possible reduction in prices of automobiles from 39 to 75 per cent in the last 10 years. Mr. McCuen cited figures to show that part of this saving, however, had been offset by taxes which have climbed some 600 per cent in 15 years. He declared that taxes paid by motorists in 1920 totaled only $295,158,000, whereas in 1934 they had risen to $1,200,108,000.

Proper management technique consists in having men with the right qualifications for their jobs, with clearly defined duties, yet stated loosely enough to permit cooperation and finally, in having each member of the organization definitely conscious of the objectives and loyal to that purpose. Industry has tried to level out employment, said Mr. McCuen, and he believes that this goal is being attained. Factories which operated throughout the winter season are now producing at top speed. Those cities in which automobile companies make their homes report better conditions than have existed since the peak years of the late twenties. Politics must be kept free from business although business and government must cooperate. Industry must insist upon freedom from outside interference and this insistence must be forcefully proclaimed. Looking into the future, industry must continue to work toward lower costs of production and consequent lower prices to the consumer.

Friday morning the entire production group paid a visit to the Ford museum and Greenfield Village as guests of the Ford Motor Co. A paper on the manufacture of laminated safety glass, prepared by R. H. McCarroll, of Ford Motor Co., was read by J. L. McCloud, Ford metallurgist, who also led the discussion.

In Ford glass manufacture, plate glass ground and polished to ⅛ in. in thickness is used for the two outer layers of the sandwich. The molten glass mixture is fused at 2600 deg. F. and held at high temperature until clear and free from bubbles. It flows from the furnace in a continuous stream onto rollers which convert it into a ribbon about ¼ in. thick. Annealed sheets are ground and polished and cut to windshield shape, washed and dried and enter a cementing chamber. The surface of the glass is coated with cement and passed through a drying oven. Operators then place a plastic sheet of cellulose acetate on the first piece of glass, to which it adheres. Care is taken to assure that no dust or dirt gets on the plastic sheet before it enters the sandwich. The second sheet of glass now is placed on the acetate sheet and the sandwich goes through a roller press where it is firmly tacked together. The edges of the glass are sealed to prevent entrance of moisture. This is done by the action of an acid mixture which attacks the plastic layer but not the glass. The groove thus formed around the edge of the glass is filled with a plastic moisture-resisting material.

Semi-Trailer Safety Device Developed by Mack Trucks

Development of a new automatic semi-trailer device known as the Mack Coincidental Safety Lock, is announced by Mack Trucks, Inc. Nose dives, runaway trailers, dragging trailer brakes, driving with support wheels down are some of the semi-trailer bugaboos eliminated by the Coincidental Safety Lock, according to the announcement.

The entire action of the Coincidental Safety Lock is automatically controlled by the normal functioning of the support wheel mechanism, thus simplifying the work of coupling and uncoupling, as well as making the operator proof against error or carelessness.

Prime component of the new device is an auxiliary fifth wheel lock comprising two heavy locking pins working vertically through holes in the upper fifth wheel plate. Except when the support wheels are fully down, these pins overlap the edge of the fifth wheel lower half, forming a secondary lock which effectively prevents accidental uncoupling, even though the driver forgets to set the king-pin latch or this latch fails.

Also controlled by the support wheel mechanism is the automatic parking brake, so that whenever the support wheels are lowered the brake is unfailingly set. Not until the wheels are raised is it released. Operating through a spring and sliding clevis, its action is positive regardless of brake adjustment, and does not interfere with power brake operation when in transit.

In addition to these two safety features a third is the safety hook, which positively prevents the raising of the support wheels or the release of the parking brake until the tractor part of the fifth wheel has been backed fully home so that the king-pin latch may trip.

Metal Statistics, 1936. Annual edition, published by *American Metal Market*, giving a complete resume of the metal industries through 1935. 572 pages. Address the publishers at 111 John St., New York. Single copy, price $2, but free with subscription.

International Trail, I.H.C.'s house organ for February, is worthy of special mention for the interesting high lights developed as it follows the International fleets. Copies may be obtained from AUTOMOTIVE INDUSTRIES.

Industrial Medicine—A monthly publication for physicians and surgeons in industry. Address Industrial Medicine, Inc., 844 Rust St., Chicago. Subscription price, $5.

Industrial America—Its Way of Work and Thought, by Arthur Pound. Twelve American Corporations, including General Motors, Goodyear, Standard Oil of N. J., and Libby-Owens-Ford, are discussed from the standpoint of their business methods and of the individual philosophies which are behind them. Published by Little, Brown and Co., Boston, in association with the *Atlantic Monthly*. Price, $2.50.

Illustrierte Automobil-Revue (Revue Automobile Illustree), March, 1936. Annual catalog number of the Swiss automobile magazine. Price, Swiss Fr. 1.00. Britenrainstresse 97, Berne, Switzerland.

Wholesale Branch Opened by Studebaker in Pittsburgh

George D. Keller, vice-president in charge of sales of the Studebaker Corp., has announced the opening of a factory-operated wholesale branch in Pittsburgh, under the direction of Paul A. Rumpf, of South Bend. The branch and salesroom is located at 5303 Baum Boulevard.

Franklin's Plans

A. J. Brandt, head of a group which recently purchased the Franklin plant at Syracuse, has stated that he expects to make an announcement of plans about the middle of May. The plant will not be ready for production, however, until some time later.

Indianapolis Prize to Be Paid Winner in Monthly Installments

The winner of the Indianapolis 500-mile race, starting with this year's event, will be assured of an income for at least a 12-month period, according to plans announced by Borg-Warner Corp. in connection with the award of their $1,200 purse. Instead of being paid in a lump sum, as has been the case heretofore, it will be paid over in monthly installments of $100.

The Borg-Warner Corp. is also giving the winner's $10,000 trophy, which is said to be the largest trophy ever given for any sporting event. It takes the place of the old Wheeler-Schebler cup of which Harry Hartz has gained permanent possession.

Borg-Warner to Experiment With the Mono-Drive Unit

The Borg-Warner Corp. has announced that an experimental license has been taken out on the "Mono-Drive" automatic transmission, but that the unit is still undergoing trials and will not be manufactured for sale for an indefinite period.

Moffett Studio

C. E. Jarchow
who has been elected comptroller of the International Harvester Co.

R. Y. Ferner Co. Appointed Agents of Schenk Products

Carl Schenk, G. m. b. H., of Darmstadt, Germany, announces the appointment of the R. Y. Ferner Co., 161 Devonshire St., Boston, as exclusive representatives in the United States and Canada for their lines of material testing equipment, dynamic balancing machines and static balancing devices.

Automotive Metal Markets

Steel Rate Has Reached 70.4 Per Cent, Probable Peak for Present Movement

Flat rolled steel producers look upon the volume of automotive business, placed in the past fortnight on the basis of the quotations and quantity discounts announced April 1, as indicating that the mark-up from the previously prevailing concession prices has safely weathered the market's test.

Some buyers, however, have been trying to obtain a more liberal construction of the "for shipment to one destination at one time" restriction of quantity deductions. Sellers most emphatically declare that there has been and will be no deviation from the schedule of prices and quantity differentials. On the other hand there has been no formal contracting on the new price basis, the business placed coming in the form of specifications and shipping orders and covering definitely needed material beyond what may be due to buyers by way of first quarter obligations.

Mills are operating at top rates to clear up these arrears before the turn of the month. All of these developments reflect the insistence of leading automotive buyers that, while they want to see orderly, rather than demoralized conditions in the steel market, their production costs and the price they get for their finished units are so closely calculated that even a slight bulge in their steel bill at this time presents a serious problem.

With this week's rate of employed ingot capacity reported by the American Iron and Steel Institute at 70.4 per cent, approximately 3 per cent higher than in the preceding week, many steel market observers believe that the peak of the present movement has been reached, while some of the more skeptical see a certain amount of stocking by the mills as the prop for the week's unusually high rate of activity.

Pig Iron—The number of furnaces in blast is on the uptrend, indicating broader demand from melters. Prices are uniformly well maintained. Automotive foundries frequently ask shippers to take special pains to see to it that iron reaches them promptly, from which it is deduced that the reserves of some buyers are extremely light.

Aluminum—Routine conditions prevail in the market for both primary and secondary aluminum. The supply of scrap from Detroit automobile plants is good, but demand for clippings from secondary melters tops the supply.

Copper—With the consuming demand covered for some time ahead during the last week of 9¼-cent copper, the market now rules very quiet. The so-called "outside" market is now quoted on a parity with the producers' price of 9½ cents.

Tin—Good buying by consumers in the New York market was reflected in slightly higher prices on the London and Singapore exchanges at the beginning of the week. The opening price for spot Straits in New York was 46⅞ cents, about ¼ cent higher than at the preceding week's close.

Austin to Spend £400,000 On Additions to Its Plant

The Austin Motor Co., of Birmingham, England, is to spend £400,000 on further extensions and a new plant at its Longbridge factory, according to British reports. Details of the extension plans have not yet been made public, but it is understood the company aims not only to increase its production facilities but to effect a lowering of manufacturing costs.

Foundry equipment at the works is to be augmented by a cupola of the balanced blast type fitted with automatic air-weighing instruments to secure complete combustion of fuel, and controls for charging the raw material and fuel under conditions of the strictest accuracy. A cupola of this type is already in use at the works.

The Austin company is also considering the manufacture of light airplanes, it is understood. The plane under study would be produced in large quantities to sell for less than £300. The company owns an airport adjoining the factory which would provide testing facilities.

The present Longbridge automobile plant is the largest motor factory in the British Empire and comprises foundries (iron and steel), forges, machine and erecting shops, radiator and press shops, complete body shops and a service station. When operating at its peak, 20,000 persons are employed.

Calendar of Coming Events

SHOWS

Yugoslavia, Automobile Show, Zagreb, May 2-11
Foundry and Allied Industries Exposition, Detroit .....May 4-9
Spain, Automobile Show, Madrid, May 10-20
International Aero Exhibition, Stockholm, Sweden .....May 15-June 1
International Petroleum Exposition, Tulsa, Okla. .....May 16-23
Morocco, Fair of Tangiers.....May 16-24
Yugoslavia 16th International Spring Fair, Lubliana .....May 30-June 11
France, Automobile Exhibit at Foire de Paris .....May
Norway, Automobile Show, Oslo .....May
Olympia Motor Show, London, England, Oct. 15-24
National Motor Truck Show (N. J. Motor Truck Assn.), Newark, N. J., Nov. 3-7
National Automobile Show, Grand Central Palace, New York.....Nov. 11-18
International Aviation Show, Paris France .....Nov. 13-29
Columbus Automobile Show.....Nov. 14-20
Chicago Automobile Show.....Nov. 14-21
Detroit Automobile Show .....Nov. 14-21
Cincinnati Automobile Show ....Nov. 15-21
Baltimore Automobile Show ....Nov. 21-28
Brooklyn Automobile Show ...Nov. 21-28*
Cleveland Automobile Show.....Nov. 21-28
Kansas City Automobile Show..Nov. 21-29*
Milwaukee Automobile Show ....Nov. 22-29
Peoria Automobile Show ..Nov. 30-Dec. 5*
Philadelphia Automobile Show, Nov. 30-Dec. 5*
Natl. Exposition of Power & Mechanical Engineering, Biennial Meeting, New York City .....Nov. 30-Dec. 5
International Commercial Motor Transport Exhibition, London, England, November

* Tentative dates.

CONTESTS

500-Mile International Sweepstakes, Indianapolis .....May 30

CONVENTIONS AND MEETINGS

U. S. Chamber of Commerce, Annual Meeting, Washington .....April 27-30
American Foundrymen's Association 40th Annual Convention, Detroit, May 4-9
American Petroleum Institute Mid-Year Meeting, Tulsa, Okla..May 13-15
National Battery Manufacturers Association, Spring Convention, Cleveland .....May 20-21
American Iron & Steel Institute, Annual Meeting, New York City..May 21
S.A.E. Summer Meeting, White Sulphur Springs, W. Va. .....May 31-June 6
Automotive Engine Rebuilders Assoc. Annual Convention, Cincinnati, June 1-4
American Society for Testing Materials, Annual Meeting, Atlantic City .....June 29-July 3
National Association Power Engineers, Annual Meeting, Chicago, Aug. 31-Sept. 4
American Society for Metals, 18th Nat l Congress, Cleveland, O. ....Oct. 19-23
American Gas Association, Annual Meeting, Atlantic City .....Oct. 26-31
American Petroleum Institute, Annual Meeting, Chicago .....Nov. 9-12
Natl. Industrial Traffic League, Annual Meeting, New York City....Nov. 19-20

30 Miles-Per-Gallon

from an American Production Car ?

By P. M. Heldt

NOW that the production of cars capable of 30 miles per gallon, by American manufacturers in the popular-priced field, has been foreshadowed, it is interesting to speculate on what kind of car can be produced to show such a performance. The principles governing the power requirements of cars of various weights and bulks at different speeds, and those governing the variations in the fuel consumption of engines with load and speed, are fairly well established, and if the 30-mile-per-gallon car become a reality it is much more likely that it will be the result of a skillful application of known principles than of the discovery of new ones. Present-day popular-priced cars give only about 20 miles per gallon under favorable conditions, and it seems hardly possible that the fuel mileage could be increased 50 per cent without some sacrifice in respect to acceleration. The fuel consumption per mile increases, of course, with the weight and bulk of the car, and quite rapidly with the speed, and in view of the latter fact it would probably be too much to expect the given fuel mileage to be obtained at maximum car speed; in fact, if the car did 30 miles to the gallon at a moderate touring speed of, say, 40 m.p.h. it would be a quite creditable performance—provided, of course, that it were substantially as roomy as modern low-priced American cars and had an acceptable acceleration. It is found much more difficult to reconcile economy with modern accelerating requirements than with speed requirements.

In order to obtain the required fuel mileage, the engine size must be held down, so that the engine will carry a fair torque load at the car speed at which most of the driving is to be done, and in order to get satisfactory acceleration with this small engine the car weight must be kept down. In addition, the car should be well streamlined, as the air resistance affects the economy throughout the speed range, but particularly at the higher speeds. To further increase the economy of operation of the engine an over-drive must be provided which will increase the power factor of the engine, and, finally, engine and fuel system must be designed for maximum economy.

It should be quite possible to produce a small car, designed to carry not more than five people, to weigh not more than 2400 lb. empty and 2800 lb. with two passengers and supplies. This is considerably less than the weight of the average present-day low-priced American car, but a reduction in weight would be made possible by the contemplated reduction in engine power and maximum speed. Bodies would have to be of substantially the same cross section as a present, and a forward projected area of 25 sq. ft. would have to be figured with.

On smooth, hard, level road surface the coefficient of rolling resistance at moderate speed is of the order of 15 lb. per 1000, and the recent coasting tests at Kansas State College indicate that if the body is well streamlined, the coefficient of air resistance may be as low as 0.00125. The rolling resistance of the 2800-lb. car then is 42 lb. and the air resistance at speed of V m.p.h., $0.00125 \times 25 \times V^2$ lb. The total propulsive force required then is

$$F = 42 + (0.00125 \times 25 \times V^2) \text{ lb.} = 42 + 0.0313\ V^2 \text{ lb.}$$

As the speed of the vehicle is equal to 88 V ft. per minute, the horse power consumed in propelling the vehicle will be

$$\text{Hp.} = 88\ V\ (42 + 0.0313\ V^2)\ /33{,}000 = (3700\ V + 2.75\ V^3)/33{,}000$$

This equation gives the horse power required at the road wheels and includes also the losses in the transmission when

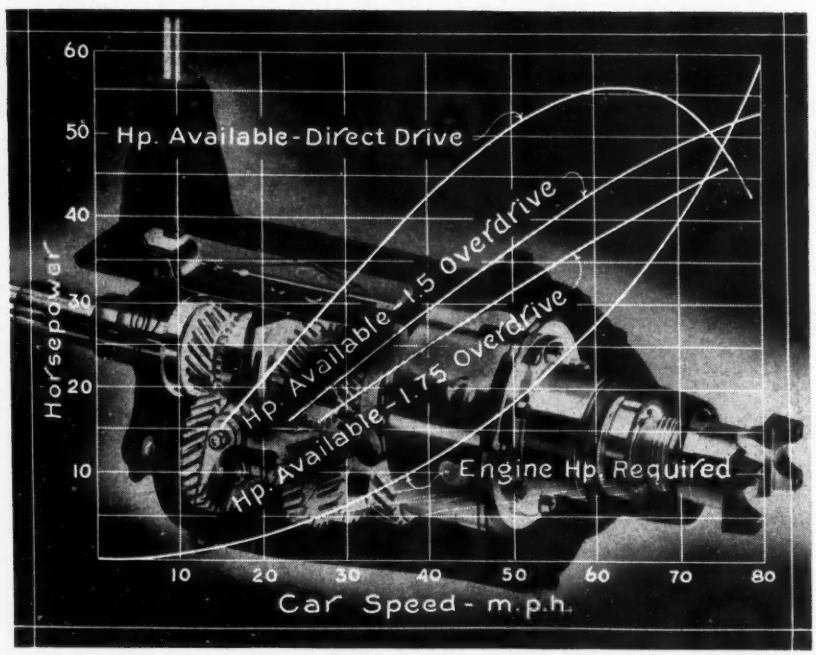


Fig. 1—Horsepower-speed curves for 2400-lb. car with 25 sq. ft. frontal area

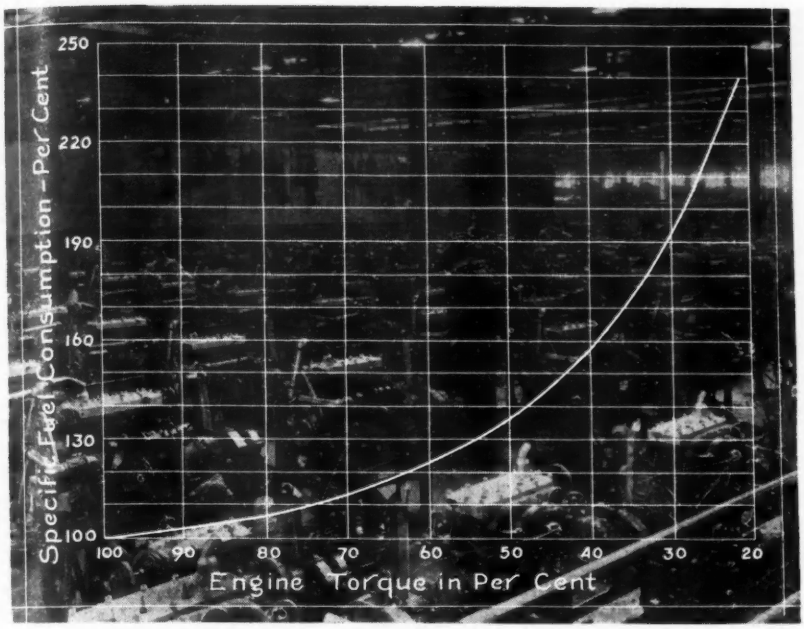


Fig. 2—Variation of specific fuel consumption with torque load

coasting. Losses in the transmission will be slightly greater when power is being transmitted. Besides, a certain amount of power is required to drive the engine accessories, such as the fan, water pump and generator, which is generally not considered when fuel consumption tests are made. An allowance of 10 per cent of the power applied to the road wheels would take care of these two sources of "loss" of engine power. The equation for the "engine horse-power required" by this particular car then becomes

$$\text{Hp.} = (V/8.1) + (V^3/10{,}900)$$

A curve of horse power vs. speed, based on this equation, is plotted in Fig. 1.

In determining the size of engine required, acceleration requirements must be considered first. A good index of the accelerating ability of a car is the displacement factor, which is obtained from the equation

$$F = \frac{3825\, r\, D}{W\, d},$$

where r is the ratio of crankshaft to drive-wheel revolutions; D, the piston displacement in cu. in.; W the weight of the car plus 300 lb. for two passengers, and d the wheel diameter in in. The best-performing modern cars have a displacement factor of about 40. One popular car has a displacement factor of 32.5. Since "high performance" or great accelerating ability is incompatible with economy, and the car here considered is to be economical far beyond present-day cars, it seems that a displacement factor of 30 should be satisfactory. Moreover, in order to get this displacement factor with a comparatively small engine, the reduction ratio r must be high. Most of the present popular-priced American cars have a reduction ratio of 4.11 or thereabouts, but as this "economy car" is to have an overdrive, which will take care of the high-speed range, the direct-drive ratio can be made considerably greater in it. A ratio of 5 to 1 would probably be satisfactory. The weight with 300 lb. for passengers will be 2700 lb. and if the wheel diameter is 28 in. we get

$$30 = \frac{3825 \times 5 \times D}{2700 \times 28},$$

from which we find D to be 118 cu. in. (say 120 cu. in.) as the necessary piston displacement.

An engine of this small size could readily be operated at 4000 r.p.m. peaking speed, and if we figure on a b.m.e.p. of 92 lb. per sq. in., which is the average of all present-day passenger-car engines, it would have a maximum output of

$$\frac{120 \times 4000 \times 92}{792{,}000} = 56 \text{ hp.}$$

We have assumed that the direct drive ratio is 5 to 1 and that the nominal wheel diameter is 28 in., corresponding to an effective diameter of 27 in. From this it follows that when the engine is running at its peaking speed of 4000 r.p.m. in direct drive the car speed is

$$\frac{4000 \times 27}{336 \times 5} = 65 \text{ m.p.h.}$$

Having thus determined the peak point of the horse power curve (56 hp. corresponding to 65 m.p.h. car speed in direct drive), we can draw the whole curve with a considerable degree of accuracy, for the reason that horse power curves of all gasoline engines when drawn to the same scale are very similar in shape. Engines will develop about 90 per cent of their peak hp. at 75 per cent their peaking speed, 63 per cent of their peak hp. at 50 per cent their peaking speed, and 30 per cent their peak hp. at 25 per cent of their peaking speed. The curve marked "Horse Power in Direct Drive" in Fig. 1 was drawn on this basis. In Fig. 1 there are also shown two engine horse power curves for overdrives, one for an overdrive with a ratio of 1.5: 1 and the other for an overdrive with a ratio of 1.75: 1. These curves are obtained by multiplying the abscissas of different points of the curve for "Horse Power in Direct Drive" by 1.5 and 1.75 respectively.

By comparing the curve marked "Horse Power Available in Direct Drive" with that marked "Horse Power Required to Propel Car," it will be seen that at such moderate speeds as 40 m.p.h. only a relatively small fraction of the available power is required to propel the car. This is unfavorable to

Criteria for Economy

In order to increase fuel mileage it is necessary to make a car light, to streamline it well, to provide it with an overdrive to increase the load factor of the engine and to hold the latter down to a moderate speed, and to so design the engine and fuel system as to secure a relatively high thermal efficiency.

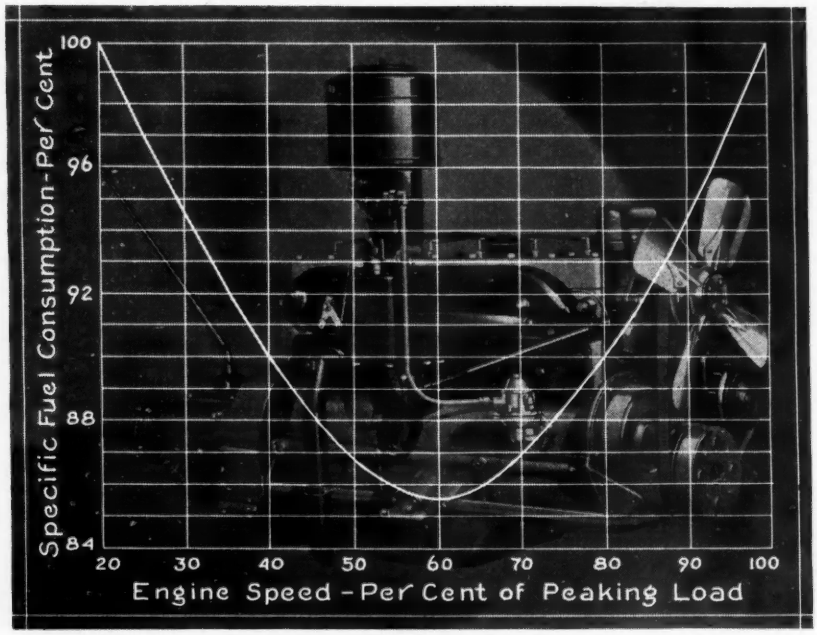


Fig. 3—Variation of specific fuel consumption with engine speed

economy, because the efficiency of the engine increases with the load on it. The use of the overdrive materially increases the load on the engine for any given car speed. How the specific fuel consumption varies with the load on the engine is shown in Fig. 2 on a percentage basis. The specific consumption of the engine when under full torque load is called 100 per cent and the specific consumption at various part loads, in per cent of that at full load, can be read directly from the chart. Besides varying with the torque load, the specific consumption also varies with the speed of the engine, and the relationship between speed and specific consumption is shown in Fig. 3.

Now let us assume that the car is being driven at 30 m.p.h. in the 1.5 overdrive. The engine hp. required is 6.2 and the hp. available in the 1.5 overdrive is 21.2, hence the torque load on the engine is 29 per cent. The speed of the engine is 31 per cent of the peaking speed. From Fig. 2 we see that the torque factor of the fuel consumption is 1.95, and from Fig. 3 that the speed factor is 0.94. Therefore, if the specific consumption of the engine at full load (peak load) is f, then the specific consumption under the conditions of operation here considered is $1.95 \times 0.94\ f = 1.87\ f$.

As the engine develops 6.2 hp. the hourly consumption will be

$$6.2 \times 1.87\ f = 11.6\ f \text{ lb.}$$

which, since gasoline weighs about 6.1 lb. per gallon, is equal to $1.9\ f$ gal. As the car is running at 30 m.p.h. and is to do 30 miles to a gallon, the hourly consumption should be 1 gal.; consequently

$$1.9\ f = 1,$$

and $f = 1/1.9 = 0.53$ lb. per hp.-hr. at maximum engine load. This seems to be an attainable figure for a small, high-speed, high-compression engine, considering that the power required for driving the accessories has been allowed for and the specific consumption can be figured on the gross shaft horse power of the engine.

It will be interesting to see how the overdrive ratio and the speed affect the fuel mileage. To this end let us assume that the engine has a specific fuel consumption of 0.53 lb. per hp.-hr. at peak load. Assume also that the engine is being driven at 30 m.p.h. in the 1.75 overdrive. The horse power available at 30 mp.h. in this gear is 17.8, and as the horse power required is again 6.2, the torque load is 35 per cent. The speed is 26 per cent of peaking speed. Therefore, the torque factor is 1.72 and the speed factor 0.97. Consequently, the specific consumption is

$$0.53 \times 1.72 \times 0.97 = 0.885 \text{ lb.}$$

or

$$0.885/6.1 = 0.145 \text{ gal. per hp.-hr.}$$

The hourly consumption will be

$$6.2 \times 0.145 = 0.9 \text{ gal.}$$

and as the car makes 30 miles per hour, the fuel mileage is $30/0.9 = 33.3$ miles. Thus at 30 m.p.h. the 1.75 overdrive gives about 10 per cent greater fuel mileage than the 1.5 per cent overdrive.

Now let the car be driven at 40 m.p.h. in the 1.5 overdrive. The horse power required is 11, the torque load is 39 per cent of maximum load and the speed 41 per cent of peaking speed. The torque factor is 1.60 and the speed factor 0.895. Therefore the specific consumption is

$$1.60 \times 0.895 \times 0.53 = 0.77 \text{ lb. per hp.-hr.} = 0.126 \text{ gal. per hp.-hr.}$$

The hourly consumption therefore is

$$11 \times 0.126 = 1.385 \text{ gal.}$$

and since the car covers 40 miles per gallon, the fuel mileage is

$$40/1.385 = 29 \text{ m.p.g.}$$

When the car is being driven at 40 m.p.h. in the 1.75 overdrive the torque load is 45 per cent and the speed 35 per cent of the peaking speed. The torque factor then is 1.475 and the speed factor 0.92, so that the specific consumption is

$$1.475 \times 0.92 \times 0.53 = 0.72 \text{ lb.} = 0.118 \text{ gal. per hp.-hr.}$$

The hourly consumption then is

$$11 \times 0.118 = 1.296 \text{ gal.}$$

and the fuel mileage

$$40/1.296 = 31 \text{ m.p.g.}$$

The car thus gives from 2 to 3 miles per gallon more in the 1.75 than in the 1.5 overdrive.

It will be seen from Fig. 1 that the car will do over 70 m.p.h. in both direct drive and in either the 1.5 or the 1.75 overdrive, hence all legitimate speed requirements are satisfied.

Converts Gasoline Engine to Run on Fuel Oil

NUWAY ENGINEERING CORPORATION, 2040-42 Livernois Avenue, Detroit, has developed an equipment by means of which a gasoline engine can be converted to run on fuel oil. The equipment comprises an oil-preheating unit and a thermostatically controlled hot air unit, all heat coming from the exhaust gases. The oil arrives from the vehicle tank through a filter and pump and passes through the oil preheater. While the engine is being started on gasoline, the heavy-fuel line is shut off from the carburetor and the oil returns to the tank through a pressure-release valve. A tube leads from the hot-air line of the carburetor to a thermometer on the instrument board, and when this instrument shows 140 deg. F., the operator pulls out a knob on the dash, thereby operating a three-way valve which shuts off the gasoline and admits fuel oil to the carburetor on which the operation continues.

JUST AMONG OURSELVES

Wages Continue Upward Trend

"THE triumph of the American system is to cut prices and raise wages." The quotation is from W. J. Cameron's talk on the Ford Sunday evening hour of April 5, one of the talks in the now celebrated series. In this particular talk Mr. Cameron analyzed Ford wage figures for 1935, pointing out that the average wage of all shop employees in the Ford plants was $1,372 for the year—that 59 per cent of the shop employees worked the full year and received an average of $1,600.

As this is written, comparable wage figures for the General Motors Corp. are not available, but informal and unofficial analysis indicates that there was a real rise in 1935, and that the G.M. figures will compare very favorably with those of the Ford Motor Co. We mention this, not to bring up individous comparison, but to emphasize the fact that the automobile manufacturing industry is, on the whole, doing a good job of increasing its average wage scale and providing additional security of employment through its own efforts, and without legislative control, at the same time justifying fully the contention of another authority that "the industry, after two years, continues to lead the industries of America in the march to normal prosperity."

Annual reports of many companies are beginning to be concerned with general economics, as we have pointed out before, and any company which does not take the occasion of an annual report to give an account of its wage position seems to us to be neglecting an opportunity.

The triumph of the American system is being made manifest, as it has before by the operations of the automotive industry. This triumph will continue to have meaning so long as it continues to be free from undue legislative interference.

A Statue Asked For de Rochas

IN the February issue of the *Journal* of the S.I.A., just received, M. A. Labarthe, a prominent member of the French society, pleads for better recognition of Beau de Rochas as the formulator of the four-stroke cycle for internal-combustion engines. Otto, whose name is commonly associated with the development, was a constructor, perhaps a constructor of genius, M. Labarthe points out, but to de Rochas must go the credit for the intellectual contribution to engineering progress. Calling attention to the fact that Otto is mentioned in the leading French reference books, while de Rochas is ignored, M. Labarthe concludes with a whimsical bitterness that France must be indeed prolific in genius if she can afford to cast the name of a real genius into the gutter.

A movement is on foot to erect a statue to de Rochas, and so give belated recognition to the inventor of the "cycle a 4 temps."

Looking Backward For 1936 Answer

WITHIN the past year the voices of authority have been raised several times in soft, but articulate, protest against the present trend in the appearance of passenger cars. Walter Dorwin Teague, industrial designer, has been heard with respect. Recently, Homer St. Gaudens, of the Carnegie Institute, had some very trenchant things to say about the futility of streamlining the comfort out of a car.

These things were brought forcibly to mind by a conversation we had recently with a designer—in the graphic arts field—whose name is top-of-the-list wherever fine books are appreciated throughout the world.

B. R., as he is known to most of the people in his own profession, remarked that he had bought a car the other day and, of course, several people asked him what kind. "Oh," he said, "a 1934 Ford," which didn't seem to interest anybody much until he added, "You know, that was the last decent exterior design of an American car."

That started the fun. There were several other designers of printing around the table, and most of them were inclined to agree with the speaker.

Additional point is given to what might otherwise be considered as random opinions by a glance at competitive passenger-car sales figures for the first quarter of this year.

And as a footnote, to give license to a printing designer's authority as a critic of motor-vehicle design, it may interest you to know that Walter Dorwin Teague was a designer of printing long before the more general term "industrial designer" came into vogue. —H. H.

Tractors Emerge—

THE two-day meeting held by the S.A.E. at Milwaukee last week proved a success in every way. It was well attended and the papers were above average in quality. Officially it was known at the S.A.E. National Tractor Meeting, but the variety of topics covered in the papers presented gave it a somewhat wider scope. The tractor element undoubtedly predominated at the meeting, and the greatest interest centered in the final session devoted to tractor engines and fuels. This was the only one at which there was an animated discussion. Two other sessions were devoted to applications of tractors and kindred automotive products—in road building and maintenance and in army mechanization respectively. On Thursday morning Raymond W. Young of the Wright Aeronautical Corporation, read a paper on aircraft engine development, and while there were probably very few aircraft engine designers in his audience, he was listened to attentively, for as pointed out in the discussion, the methods employed by aircraft engine manufacturers in boosting the outputs and efficiencies of their engines, might well be studied and followed by designers of tractor and other heavy-duty engines.

The meeting opened with a paper by E. L. Roettiger, State Highway Engineer of Wisconsin, on "Tractors and Industrial Power Equipment in Highway Maintenance and Construction." Mr. Roettiger said that from 25 to 50 per cent of the total highway mileage built during the past 10 years is in need of some degree of modernization, when measured by present accepted standards. Fig. 1 is a comparison of the cross-sections of primary rural highways of 15 years ago and of today. Fifteen years ago the grades ran as high as 8 per cent, sight distances at apices of grades were as low as 300 ft., and radii of curves as low as 500 ft. Present designs for similar highways, in addition to providing a roadway of more liberal size as shown by the drawing, limit grades to 5 per cent, make sight distances from apices 800 ft. or more, and horizontal curves with radii of 1000 ft. or more, besides which the banks are superelevated or banked to permit speeds of 70 m.p.h. Present designs further hold to improved standard of alignment and grade when obstacles are encountered, even at the expense of a large amount of costly work.

As a result of these changes, the amount of work done and of material required for building a mile of highway have steadily increased. Fortunately, with the number of units handled in building a mile of highway steadily increasing, the price at which these units have been handled has generally decreased so that the cost of building a mile of highway has increased only slightly. While the number of units handled at present is about 50 per cent above the 1925-9 level, the cost per mile built is only about 15 per cent above the level of that period. This trend in the unit piece and costs is due largely to the development and use of mechanical processes and devices.

Figures were quoted by the author from a publication of the U. S. Bureau of Public Roads ("An Economic and Statistical Analysis of the Highway-Construction Expenditures") which showed that for a highway-construction expenditure of $100,000,000 some of the items of equipment bought were as follows:

Trucks, $16,574,000.

Power shovels, cranes and draglines, $11,485,000.

Tractors, $5,061,000.

The total equipment charge on the $100,000,000 construction includes $7,454,500 for trucks and $1,109,400 for their transportation to the jobs, $3,798,500 for power shovels, cranes and draglines, and $379,300 for their transportation, and $1,874,500 for tractors and $187,200 for their transportation.

The author explained in some detail the mechanized units used for various lines of construction work and also went into the details of the mainte-

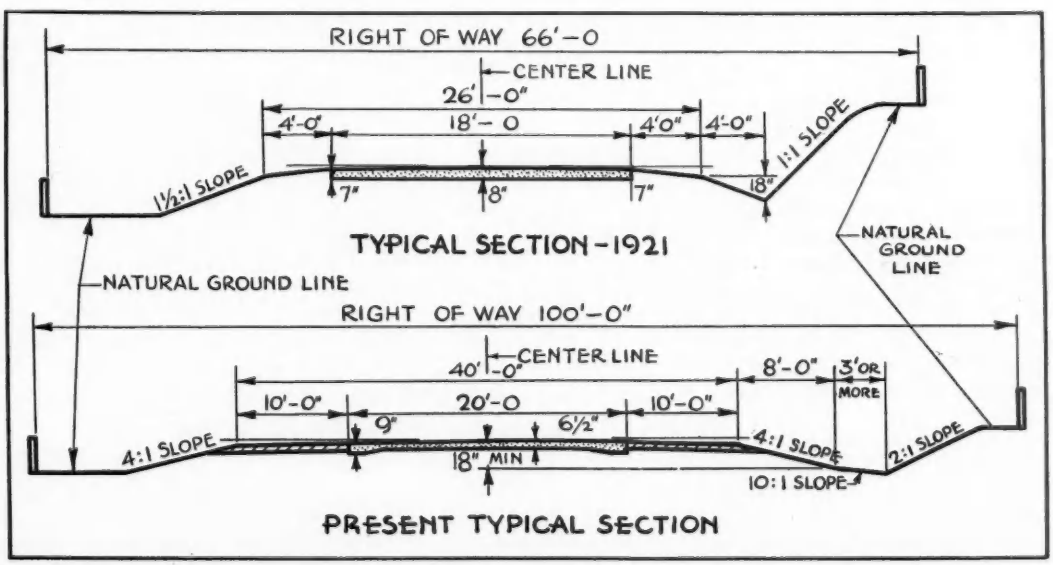


Fig. 1.
Sectional views of road construction showing the progress made since 1921

to meet new needs of Peace and War. SAE National Tractor Meeting hears of new developments.

nance practice of his department. In recent years maintenance work has also included snow removal operations. Snow removal equipment usually consists of one-way blade or V-type plows mounted on ordinary motor trucks or crawler-type tractors. The equipment may be classified on the basis of the speed of the vehicle upon which it is mounted, and the shape of the blades or moldboards, as speed-type plows or displacement-type plows. The foregoing types of equipment are supplemented with rotary-type plows and motor graders. Owing to variations in the conditions encountered, more than one type of equipment is usually necessary.

As an index of the amount of motorized equipment needed to maintain the highway system of the nation, the following list of the principal types of blade, tractor and truck equipment used in maintaining Wisconsin's 10,000 miles of State trunk highways in 1935 is of interest.

Motor Graders	300
Small Trucks (1½ to 3 Ton)	250
Large Trucks (3 to 7 Ton)	590
Tractors	225
Rotary Snow Plows	8
One-way Truck Mounted Snow Plows	200
V-type Truck Mounted Snow Plows	450
V-type Tractor Snow Plows	125

Present trends in equipment for highway construction and maintenance were listed as follows by the author: (1) Fast, large-capacity units; (2) full power operation; (3) centralized and easier control; (4) increased dependability; (5) lower cost of operation, and (6) specialized machines for individual operations.

Mr. Roettiger was followed by H. B. Dodge of Four Wheel Drive Auto Company, who exhibited several reels of moving picture showing the trucks of his company in use in road construction work. A feat that excited particular interest consisted in a truck with V-type mold-board running time after time full tilt into a dirt bank, moving it little by little. Commenting on this, a later speaker, Leonard B. Sperry of International Harvester Company, said he was no longer surprized that the fatalities among trucks and tractors in construction work were so high.

The Army Has Tractor Ideas

The gradual development of fighting equipment was traced in a paper by Maj. John K. Christmas of the Ordinance Department, U. S. Army. He emphasized the importance of tanks, the object of which, he said, was to carry the fighting soldier and his fire power safely across any type of ground to engage the enemy. In the World War, although tanks were then in their first stage of development, they proved highly efficient. French records showed that, with 4356 tanks of various sorts in battle from April, 1917, to the Armistice, tank losses due to enemy action averaged 17 per cent per attack. Only 302 tank men were killed in all these actions; the percentage of killed was 13, about one-half that of muscle-propelled infantry in similar attacks. The best endorsement of tanks, he said, was that the only nation which fought against tanks continually—Germany—is thoroughly mechanizing her new army.

One of the advantages of mechanized fighting units is that they reduce the number of men engaged, which means many less casualties. Other advantages are the greater mobility factor and the greater fire power per man engaged in battle. With mechanized units, only one-fourth as many men are exposed to casualty as in muscle-propelled units, and it is the casualties that represent the highest cost of war, both in money and human values. Mechanization lets the machine do most of the "dirty work" of war, and allows more men to stay at home to produce the greatly increased number of fighting machines required.

With this new development the demand for automotive fighting vehicles, mostly of the track laying type, becomes enormous. Considering that in November, 1918, there were on order for the mostly unmechanized A.E.F., some 22,000 tanks and 25,000 tractors, it can be foreseen that in any future major war our demand for crawler-type vehicles of all kinds will probably run into the hundreds of thousands. The automotive industry would have to supply these fighting machines.

Tactical mobility is of more importance than any other quality in a fighting machine, but high speed is also essential, and unfortunately no machines combining tactical mobility with high speed are commercially available. Development of high-speed track-laying vehicles is now the special field of the ordinance engineer, but it is hoped that before long the tractor industry will share this responsibility with the Ordinance Department.

The tank, which originated during the World War, has been greatly improved since that time in all industrial nations, principally with respect to speed and armor protection. Major Christmas said he thought the development in the direction toward higher speed had about reached its limit. Very high speeds were made possible by improvement in the weight-to-horsepower ratio of all of the propulsion elements. There has been also a great improvement in the mechanical reliability and in the mileage life, so that a tank may be expected to cover thousands of miles without mechanical failure (as contrasted with 25 to several hundred during the World War). An enormous amount of experimental work has been carried on and the world's armies today are equipped with tanks ranging from 1.5 to 94 tons in weight, 1 to 14 in number of crew, 5 to 50 m.p.h. in speed on tracks, ⅛ in. to 2 in. in weight of armor, and from a light machine gun to a 6-in. cannon in firing equipment.

Armor plate, which weighs 40 lb. per sq. ft. for a 1-in. thickness, is the principal "pay load" of the modern tank. This necessitates keeping down the weight of the tractor components, and reliability must be achieved by the use of quality materials such as alloy steels specially heat-treated, aluminum, etc. To get the high speed required it is necessary to use high-speed engines,

which are not commonly used for commercial tractors. It has been the policy of the Ordinance Department to use commercial engines, slightly modified if necessary. As regards the track-layer chassis, there are still several schools of thought as to the best compromises between requirements of speed, weight of armor, mileage life of machine and other desirable qualities.

Future tanks will have to be equipped with light high-speed engines, since tank speeds of up to 50 m.p.h. call for a specific power of 30 hp. per ton, or more. Slightly modified commercial engines are regarded by all armies as the ideal solution. Transmissions will follow commercial types in design, but the gear ratios and torque capacities required usually exceed anything available in stock automotive transmissions. Aluminum alloy cases will be used for lightness. A combination of sliding gears and jaw clutches will be used, and control will be manual. From four to five gear speeds are required to cover the wide speed range of the vehicle (2-40 or 50 h.p.h.). Transmission lubrication will be by heavy engine oil, pump-circulated, and an outside oil cooler may be required. Clutches generally are of multiple dry-plate type, foot-operated.

Steering is by clutch and controlled differential, a system similar to that used on some commercial tractors. This system does not permit of the short, pivotal turns possible with the more conventional steering clutches and steering brakes, but is well adapted to frequent small steering motions. Also, by virtue of its slower action, it decelerates the vehicle less on turns than the clutch-type of steering mechanism. Getting rid of the heat generated when steering large track-layer vehicles at high speeds is still a problem, as is that of a satisfactory lining for the steering brakes.

In order to provide a fairly steady gun platform while traveling at high speeds over rough ground, the tank must have a well-articulated suspension, with powerful inherent damping, proportional to the spring motion. The most satisfactory system so far developed comprises a two-wheel bogie whose track wheels are carried by a link system working against springs, permitting of large individual wheel movements.

Tracks of high-speed crawler-type machines are sometimes driven by a front sprocket, instead of by the rear sprocket, conventional in commercial tractors. Because of the absence of tension on the part of the track in contact with the ground, this assures full-contoured ground contact, with maximum flotation and maximum traction. It is also claimed to clear itself of dirt and to climb obstacles better. Furthermore, front drive permits of rear location of the engine and, a forward crew department assuring maximum visibility of the ground ahead.

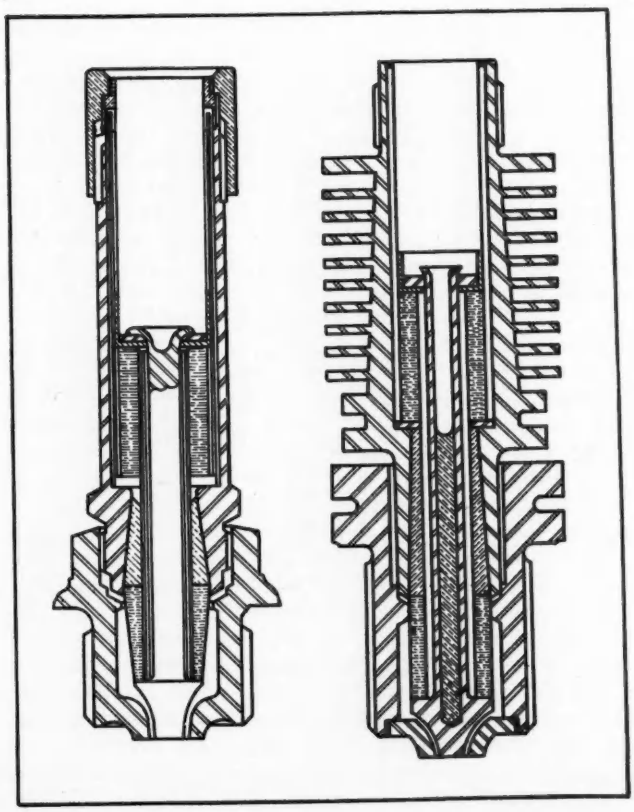
Articulated steel tracks have been highly developed, but are unsuitable for high-speed military tractors, because they wear out too quickly, have high rolling resistance, are very noisy, and injure improved highways. Rubber has the advantages of great elasticity and of better resistance to abrasion. Recently the rubber industry has developed its technique so that rubber can now be vulcanized to steel track links so securely that the rubber may carry the weight of the tank and take the abrasion. Several developments in rubber-armored track links are now in progress.

In concluding his paper Major Christmas expressed the hope that the military demand for fast tractors would have the effect of increasing the speeds of commercial tractors, with resultant mutual benefits to the industry and to national defense.

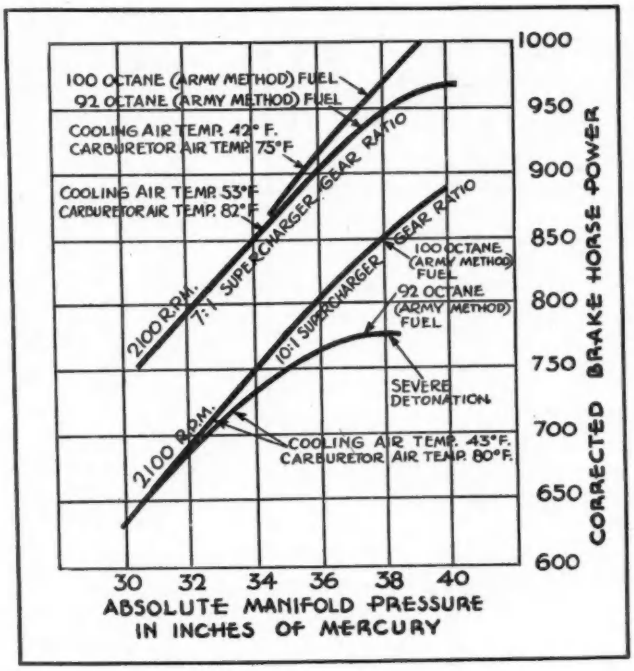
Fitting Aero Engine Developments to Tractor Needs

Raymond W. Young's paper dealt with developments in air-cooled aircraft engines generally and with recent developments in the Wright Cyclone engine in particular. These developments have raised the output of the engine until it now develops a maximum taking-off power of 1000 hp., as indicated by the graph reproduced herewith. Mr. Young let it be known, however, that the engine is still under development and that it has not yet been placed in regular production. To get this output, a low cooling-air temperature and a low carburetor air temperature are necessary. A 7:1 compression ratio was used, which was made practical in this comparatively large-bore engine by the use of fuel of 100 octane number. Among design changes made in this engine to make possible the greatly increased output may be mentioned the use of deeper and more closely spaced fins on the cylinder heads, improved sodium-cooled exhaust valves to keep down the valve-head temperature (to a faint red glow under full throttle operation), the use of aluminum pistons with heavy sections in the head and the ring belt, and the use of a special design of spark plug of which the part inside the cylinder works at a sufficiently low temperature (despite the proximity of the exhaust valve) to prevent localized heating of the electrodes with consequent preignition.

The paper also covered the automatic mixture control system worked out by Wright Aeronautical Corporation in collaboration with the Cambridge Instrument Co., and the Stromberg Carburetor Division of the Bendix



Section of spark plug used in Cyclone engine



Manifold pressure curves of Wright cyclone engine with 92 and 100 Octane fuels at 2100 r.p.m. Compression ratio 7.12 to 1. Supercharger ratio 7.14 to 1 and 10 to 1

Corporation, as well as experiments with the new 100-octane fuel which consists of a half-and-half mixture of iso-octane and aviation gasoline, which mixture is now available at 27c per gal. in tank car lots.

There was little discussion of this paper and it was rather evident that there were few aircraft-engine experts in the audience, but what little there was was highly complimentary to the author. J. B. Fisher of Waukesha Motor Co. remarked there was much in the paper that could be studied with profit by designers of tractor and other heavy-duty engines. He had been particularly impressed by the remark about going after hot spots one by one. Much could be accomplished by a careful study of exhaust valves, and plugs with a view to reducing their operating temperatures and thereby increasing the maximum useful compression ratio. In answer to a question by Max Hoffmann, the author said spark gaps had to be adjusted about every 50 hours of operation and the plugs had a life of 1000 to 1500 hr., depending on operating conditions.

Fuels—Practical and Theoretical

Earl Bartholomew of Ethyl Gasoline Corporation read a paper entitled "Tractor Engine Fuels—a Theoretical Analysis and Practical Test Results in the Laboratory and in the Field." It may be pointed out that Mr. Bartholomew confined himself to fuels for carburetor engines, and specifically compared gasoline of 70 octane number with No. 1 distillate of 44.3 octane number, which he said was quite high for distillates. The former had an initial boiling point of 87, the latter of 377 deg. F., while the end points were 399 and 491 deg. F. respectively. A table of octane ratings of six representative tractor distillates was given, which showed that they range from 10 to 43. Naturally the gasoline will stand a higher compression ratio and in the theoretical analysis compression ratios of 6.14 and 4.32 were worked with these having been shown to be permissible by experiment. Assuming the friction to be independent of the fuel burned, which seems reasonable, the mechanical efficiency at full load will be higher with the higher compression ratio. This was assumed to be 86 per cent, and calculation then gave 82.5 per cent for the distillate engine. This led to the conclusion that the higher-compression (gasoline) engine would show a brake thermal efficiency 21 per cent higher than the distillate engine.

In the second part of his paper the author dealt at length with a research program sponsored jointly by tractor manufacturers and members of the oil industry. This program was intended to furnish to tractor manufacturers the same type of fundamental data as were developed by the automobile manufacturers when it became apparent that improved fuels offered the possibility of greatly increased power and economy.

Laboratory tests were first made on a Minneapolis-Moline Model JT, tractor powered by a four-cylinder Waukesha engine. The results with respect to power and economy are compared in the accompanying table (bottom of page).

Field tests were made later by towing another tractor modified to provide for the application of variable loading. The tests were made on Munroe Dry Lake on the Mojave Desert approximately 100 miles northwest of San Bernadino, Calif.

Pros and Cons of Some Oil and Gasoline Engines

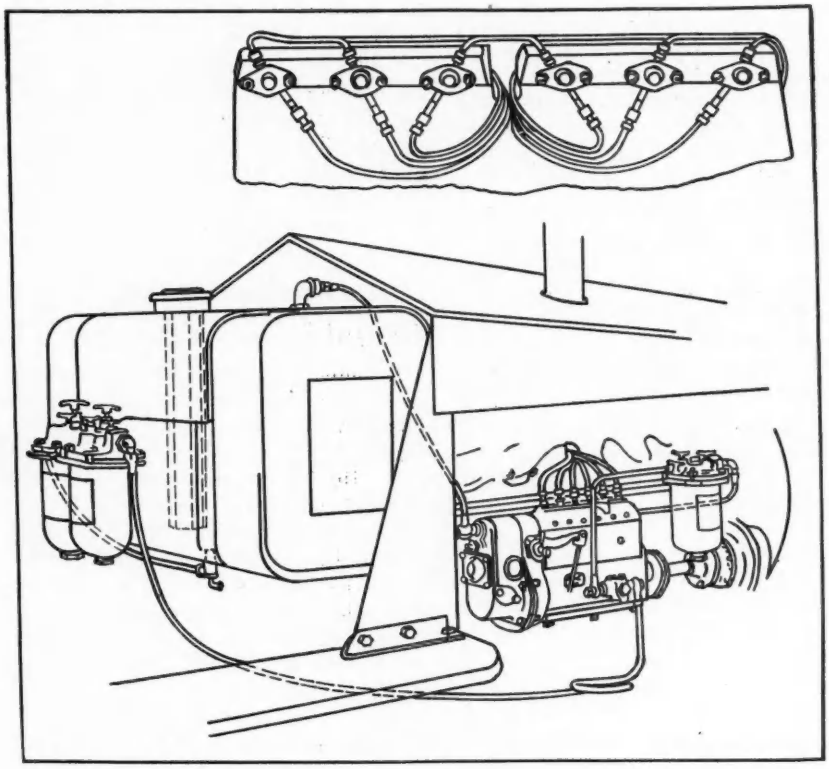
A comparison of Diesel and gasoline tractor engines was made in a paper by Ralph C. Chestnutt, chief engineer of the Cleveland Tractor Company. He first showed that, contrary to a talk on Diesel engines broadcast over the radio, the list of accessories required by the Diesel engine for tractor service is fully as long as that of accessories used with gasoline engines. The layout of the fuel lines is illustrated herewith. The comparison made by Mr. Chestnutt was based on two particular six-cylinder engines, both of the same power output at their governed speed of 1200 r.p.m. The Diesel had a displacement of 473 cu. in., the gasoline engine of 529, which made the b.m.e.p. of the Diesel higher than that of the gasoline engine (a relationship not in conformity with general experience, as was pointed out in the discussion). From the standpoint of weight efficiency the gasoline engine had it all over the Diesel, the disadvantage of the latter in this respect being, aggravated by the greater weight of its accessories. With these the Diesel weighed 43 per cent more than the gasoline engine. The reason for the much greater weight is the much higher combustion pressure.

The Diesel costs approximately 100 per cent more and with accessories, 125 per cent more.

It is a common opinion that the Diesel engine maintains its torque better at low speeds. Mr. Chestnutt included in his illustrations a collection of eight torque curves, which seemed to show quite conclusively that both

Increase in Power
and Economy by Use of Gasoline

	Increase in Power %	*Increase in Economy* %
Calculated	**30.8**	**21**
By test, with max.-power mixture	**25.5**	**18.6**
By test, with max.-economy mixture	**26.7**	**16.8**



Layout of fuel lines on a Diesel engine for tractor service

the gasoline and the Diesel engine may either maintain their torque well at low speed or else be quite inflexible, the torque characteristic evidently depending on things other than the engine cycle. One fault of the Diesel engine is the difficult cold-weather starting. The author expressed the view (indirectly) that the Diesel engine had little chance of being accepted at a passenger-car engine, because of its noise. Upkeep costs for the Diesel, he thought would be greater in proportion to its higher first cost.

After having thus attempted (as he expressed it) to remove some of the unearned glamour which has been hovering around the Diesel engine, the author came to the subject of fuel economy, and here he found the Diesel to have a decided advantage. Tests were made on a Diesel engine which delivered 55 hp. on the belt and a gasoline engine which gave 40 hp. While the outputs were not equal, they were considered sufficiently close to make the figures a suitable basis of comparison. The results were as follows:

	Consumption		*Advantage*
	Diesel	*Gasoline*	*of Diesel*
	Lb. per	*Lb. per*	*on Volume*
	B.Hp.-hr.	*B.Hp.-hr.*	*Basis*
1/1	0.49	0.66	55
3/4	0.52	0.73	60
1/2	0.59	0.89	74
1/4	0.84	1.40	91

The author expressed the views that the low economy of the gasoline engine is the fault of the cycle and that the worst feature of the Diesel is its high combustion pressure which is not accompanied by any appreciable increase in brake mean effective pressure. As long as its b.m.e.p. cannot be materially increased the Diesel will remain an engine that is heavy in relation to its power output and to its piston displacement. For that reason, the author thought, the Diesel would be used more and more for industrial power, and possibly also for agricultural purposes, unless some one should develop a gasoline engine with good part-load economy. Fortunate would be the man who succeeded in combining the economy of the Diesel with the lightness and flexibility of the gasoline engine: this name would become even greater than that of Doctor Diesel.

Gasoline vs. Kerosene

Kerosene is rapidly being replaced by lower grades of fuel, because it approaches too close to gasoline in price, said R. I. Shawl, assistant professor of Agricultural Engineering in the University of Illinois, in his paper on "Gasoline vs. Kerosene for Tractor Fuel." The fuels which are taking its place are known as distillate, tractor distillate, fuel oil No. 1, and furnace oil No. 1. These low-grade fuels, sometimes referred to as "depression fuels" have been widely used by farmers during the past few years, but according to many users, they have not proven satisfactory.

According to Bulletin No. 43 of the North Dakota Regulatory Department, issued in May, 1935, the average A.P.I. gravities of the tractor fuels sold in that State were found to be as follows: Gasoline, 62.8; kerosene, 42.5; low-flash tractor fuel, 47.9; distillate tractor fuel, 39.7; Ten per cent points (deg. F.) were as follows: Kerosene, 392; low-flash tractor fuel, 302; distillate tractor fuel, 399. End points were as follows: Gasoline, 397; kerosene, 512; low-flash tractor fuel, 501; distillate tractor fuel, 566.

Many Illinois farmers are using gasoline as tractor fuel, and there is considerable interest among the tractor owners of the State in the possibility of increasing power and decreasing consumption by using gasoline of 70 octane rating or better in high-compression engines. For this reason the Department of Agricultural Engineering of the University of Illinois converted the engine of a stock two-plow kerosene-burning tractor 10½ years old into a high-compression gasoline-burning tractor by fitting it with new sleeves, installing new pistons designed for use at 8000 ft. altitude (and therefore giving higher compression at ordinary altitude), and providing it with a cold inlet manifold and "cold" spark plugs. The best power that was obtained from this type of engine (with kerosene) in the official Nebraska type tests was 20.05 hp., and the lowest fuel consumption, 0.716 lb. per hp-hr. At the University of Illinois the converted engine gave a maximum of 26.45 hp. with a fuel consumption of 0.637 lb. per hp-hr., and in a 10 minute test it even delivered 28.48 hp. The fuel used was 70 octane gasoline. The calculated compression ratios of the original and the converted engines were 4.13 and 5.0, respectively.

This converted tractor did 1074 hr. of general farm work during 1935, giving excellent service. Owing to the use of rubber tires, which reduced shocks, it was felt safe to use the extra power due to the high-compression engine. That rubber tires reduce the stresses on the transmission parts was clearly shown by experience with this tractor. The bolts holding the differential together were rather weak in the first place, and broke several times while steel wheels were being used, but they required no replacement during the past 2½ years, with rubber tires, even though considerably greater loads had to be pulled.

The average fuel consumption per hour was greater during the period when gasoline was used, by about 16 per cent, but the consumption per acre of work done showed some advantage in favor of gasoline.

Wear measurements were made on the crankshaft bearings (the original crankshaft is still in the engine after 8464 hr. of work), and it was found that during the year the engine operated as a high-compression gasoline engine the rate of crankshaft wear was considerably less. Sleeve wear also was less when gasoline was used as fuel.

It is estimated that in Illinois there were about 60 tractors with high-compression gasoline engines in operation in 1935, most of them being converted from low-compression engines; and that several hundred additional conversions will be made this year.

It was the author's conclusion that as long as the price spread between gasoline and low-grade tractor fuels remain at 3 to 4 cents per gal., there will be a continued increase in the use of gasoline as farm-tractor fuel, and many tractors will be equipped with high-compression engines.

The Discussion

All three of the papers presented at this session were discussed together. A representative of the Caterpillar Tractor Co. expressed the view that one important factor in the situation—the purchaser—had not been sufficiently considered in the paper. "You can lead him to the water but you can't make him drink," and the tractor purchaser has his mind set on cheap fuels. His firm had changed from 100 per cent gasoline-tractor production only a few years ago to nearly 100 per cent heavy-oil-tractor production at present. If tractors are designed to be operated on high-grade gasoline, the owner is very likely to use a poor, cheap grade of fuel, and trouble will follow. But as long as the refineries turn out the lower grade of fuel, tractor manufacturers probably will have to produce tractors to operate on them, even though they are not very satisfactory.

Mr. Sperry of International Harvester stood up for the distillate engine. He objected to calling these fuels of low volatility "depression fuels," and remarked that his firm had been building tractors to operate on heavy fuels such as kerosene since 1920 or earlier. He also produced records from owners tending to show that the wear of cylinder liners and bearing surfaces was no greater in distillate than in gasoline engines.

J. B. Fisher of Waukesha Motor Company contradicted the statement made in one of the papers that the Diesel was essentially a low-speed engine. He pointed out that Diesel engines should be operated within the upper part of their speed range as much as possible and he gave data on some small Diesel engines in production by Citroen and Fiat with speeds as high as 3500 r.p.m. —P. M. H.

Small Two-Stroke Diesels

Zweitakt-Dieselmaschinen kleinerer und mittlerer Leistung (Two-Stroke Diesel Engines of Small and Moderate Output), by Ing. Dr. techn. J. Zemann, Assistant in the Department of Internal Combustion Engines and Motor Vehicles of Vienna Technical College. Published by Julius Springer, Vienna, Austria.

THE subject of small two-stroke Diesel engines is a comparatively new one and Dr. Zemann's book is a valuable contribution on it. The first part deals with calculations under such subdivisions as Scavenging Means, the Scavenging Process, the Scavenging-Air Reservoir, Design Limits for Two-Stroke Diesel Engines, Choice of Compression Ratio, Fuel Injection, Combustion and Combustion Chamber, and Determination of the Principal Dimensions, which latter problem is illustrated by practical examples.

The second part relates to design, which subject is covered under such sub-headings as Scavenging Pumps, Fuel-Injection Pumps and their Drives, Governors, Cylinders and Cylinder Heads, the Crank Train, Base Plates, Bearings, and Structures, Air-Starting and Air-Reversing Mechanisms, Flywheels, Lubrication, Cooling, Foundations for Stationary Engines, General Lay-out (brief illustrated descriptions of Austrian, German and Swedish engines) and Marine Installations. As may be inferred from this list, the subject is handled from the technical viewpoint throughout. The book also contains a bibliography.

There are 240 illustrations in the volume, a large proportion of them sectional views of actual engines and parts.

Publications Available

Better Business Letters by Earl A. Buckley. Published by McGraw-Hill Book Co., Inc., New York, N. Y. Devoted chiefly to the preparation of sales letters, this book also contains a 58-page chapter of practical suggestions for improving everyday business letters. Cloth bound. Available from the publishers. Price $2.00.

Automotive Money Saving Facts by J. F. Winchester. Published by the Traffic Publishing Co., 100 Sixth Ave., New York, N. Y. A complete volume covering every phase of automotive operation. Further details available from the publishers.

Ford Production Methods by Hartley W. Barclay, editor, *Mill and Factory*. The book form of this comprehensive study containing 215 pages of text and over 450 illustrations. Available from the publishers, Harper and Brothers, New York, N. Y. Price $5.00.

"How to Belt Your Drives for More Profit" is the title of a new manual published by E. F. Houghton & Co., Philadelphia. Transmission data, engineering tables and simple belt formulae make this 40-page booklet of more than usual interest. Copies available through AUTOMOTIVE INDUSTRIES.

The Corrosion of Tinplate, by T. P. Hoar, M.A., Ph.D.—Published by International Tin Research and Development Council, 149 Broadway, New York, N. Y.

From **Loewe-Gesfurel A. G.**, Berlin NW 87, Germany, we have received circulars describing various **machine tools** built by this firm, including high-speed draw-spindle lathes, disk lathes, production lathes, turret lathes, horizontal milling machines, vertical milling machines, high-speed drill presses, optical profiling machines, universal tool grinders, tap grinders, measuring gage for involute milling cutters, and reamer-whetting apparatus. The circulars are printed in German.

A new catalog has just been released by the Chicago Wheel & Mfg. Co. covering the company's full line of **grinding equipment** together with current list prices. Copies are available through AUTOMOTIVE INDUSTRIES.

Truck Safety is the theme of a 24-page booklet just published by the Four Wheel Drive Auto Co. Many illuminating accident statistics as well as F.W.D.'s safety performance records are covered. Copies may be obtained from AUTOMOTIVE INDUSTRIES.

The first issue of **New Horizons**, the Aerial Travelogue, draws considerable interest for the excellence of its make-up as well as the romantic story which it unfolds of Pan American Airways' routes. This magazine is to be published quarterly by Somerset Publishing Co., 461 Eighth Ave., New York, N. Y. Subscription price, $1.50 per year.

Two new information sheets, giving interesting test-data, dimensions, prices and hook-ups for the **"Ohiohm"** series of automobile radio interference suppressors manufactured by The Ohio Carbon Co., 12508 Berea Road, Lakewood, Ohio, are now available on request from the manufacturers.

Better Braking...

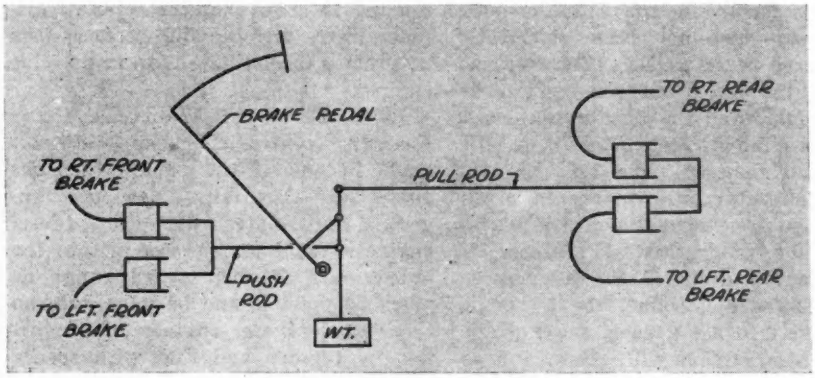


Fig. 1—Automatic control of division of the force of brake application between front and rear.

THREE improvements in brake-control mechanism, designed to increase the safety of automobiles in operation, have been evolved by the United States Ordnance Co., Washington, D. C. They include—

1. A mechanism for increasing the force of brake application at the front wheels in proportion to the rate of deceleration.

2. A mechanism designed to equalize the retarding forces (instead of the forces of application) of brakes on opposite sides of the car, and,

3. An automatic take-up to compensate for lining wear.

These three mechanisms have been worked out for application to hydraulically-actuated brakes, and they are illustrated diagrammatically in Figs. 1, 2 and 3 respectively. These sketches are quite elementary and are not intended to represent the finished product.

In Fig. 1 there are four "master cylinders," or cylinders in which the brake fluid is put under pressure. The linkage connecting the brake pedal to the pistons of these cylinders is clearly shown, and comprises a balance lever between the pull rod to the rear, and a push rod to the forward master cylinders. There is a link connection from the brake pedal to an intermediate point of this balance lever, and the normal division of brake-operating force between front and rear brakes depends upon the location of the point of connection on the balance lever. It will be seen that the balance lever has a downward extension which carries a weight at its lower end. When the brakes are applied smartly and the car is decelerated strongly in consequence, the weight tends to move forward relative to the car, thereby increasing the push on the pushrod (and the force of application of the front-wheel brakes). The deceleration of the car throws additional weight onto the front wheels, thereby enabling them to take additional brake loads, and if the division of the force of application is changed accordingly, the minimum distance in which the car can be stopped is reduced.

The ordinary brake-equalizing mechanism equalizes the forces of application of the brakes on the right and left sides. Even if such an equalizing mechanism is entirely effective, it does not assure that the retarding effects of the brakes on opposite sides will be the same, as the retarding effect is dependent also on the friction coefficient between brake shoe and brake drum and possibly on the friction coefficient between tire and road. Inequality of the retarding effects of the right and left brakes is largely responsible for skidding, and it is evidently more desirable to equalize the braking forces than the forces of application between the wheels on opposite sides.

The principle involved in the equalization of braking forces on opposite sides of the car is illustrated by Fig. 2. A cross connection is provided between the brake anchors on opposite sides, so arranged that the two brakes can rotate slightly around their axis, but only in opposite directions. The point of anchorage of the brake shoes is at the end of one arm of a bell crank mounted on the axle, and the other arm of the bell crank connects by a link to the corresponding arm of the bell crang on the opposite side. As the shoes are applied, they tend to rotate with the drum, and the expanding mechanism is so arranged that this motion of the shoe moves the brake lever away from the applying cylinder, thereby reducing the applying pressure. On the opposite side, where the retarding force is less, the brake shoe will be moved in the opposite direction, and the applying pressure will be increased in consequence. Hence, if either brake tends to take more than its proper share of the load, it is slightly released, and by means of the cross

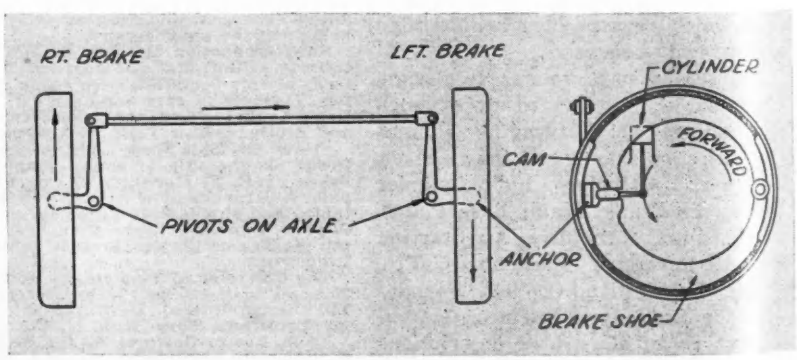


Fig. 2—Equalization of braking effect between right and left.

May result from three improvements for hydraulic brakes and help efficient operation

connection the brake on the opposite side is slightly tightened, so that the actual braking effects are equalized.

The automatic brake adjustment, illustrated in Fig. 3, is controlled by the force-balancing mechanism in such a way that the brake which is least effective and whose effectiveness is increased by this balancing mechanism, is always the one to be adjusted first. Adjustment is accomplished by the action of a pawl on a ratchet wheel, and movement of this pawl is effected by the pull of a wire connecting the two brake shoes. As the shoes are expanded, the wire is moved a corresponding distance in the direction of its length, and this movement depends primarily on the state of wear of the linings. The motion, however, will be increased or decreased by the action of the force-balancing mechanism as it tends to further expand the weaker and slack up on the stronger brake. If any one of the brakes gets abnormally hot, a thermostatic device limits the adjusting operation. The arm of the pawl is made of steel and bronze, and as the arm is heated it bends toward the pull wire, thus reducing the throw of the pawl and delaying the adjusting action. The tendency of the brake to "over-adjust" when the brake drums expand abnormally due to extreme heating is compensated for, and locking of the brake when cooling from such abnormal temperatures is guarded against.

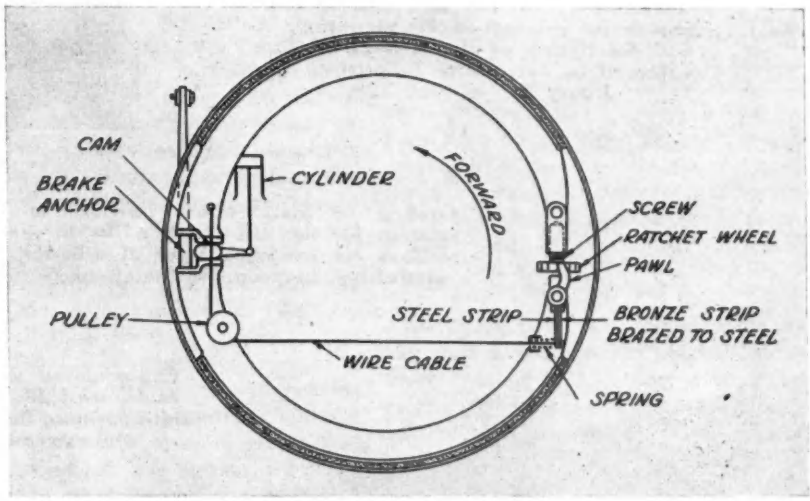


Fig. 3—Automatic brake adjustment with thermostatic device preventing over-adjustment due to excessive heat-expansion of drum.

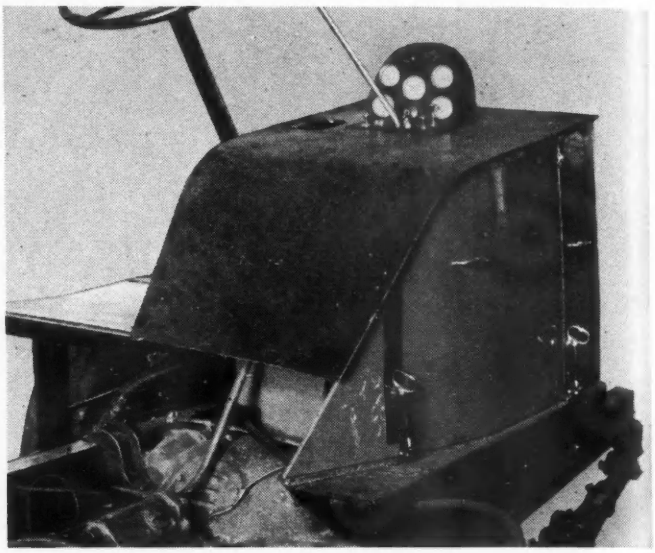
. . . and Germany Too Is Interested in Brakes

THE high-speed articulated train brought with it a number of new problems in brake design and brake control. Railway signalling systems are laid out on the assumption that trains can always be brought to a stop within a given maximum distance, and unless the whole signalling and safety installation of the railroads were to be revamped, the new articulated trains had to be provided with sufficient braking power so that they could be stopped within this distance, notwithstanding their much higher speed. The braking equipment includes the usually cast-iron brake shoes. It is one of the characteristics of such brakes that the coefficient of friction between shoe and wheel decreases as the speed increases. On the other hand, tests on the Zephyr high-speed trains and similar tests conducted in Germany recently have shown that there is no appreciable decrease in the adhesion between the wheels and the rails with an increase in speed, so that the same braking force can be utilized at low as at high speeds. In order to make the stopping distances from high speeds come within the limit above referred to, it is necessary to fully utilize the adhesion of the wheels at high speeds. This calls for greater forces of application at high speeds than are necessary at low speeds, and if the maximum necessary force of application were made available at all speeds then there would be danger of locking the brakes at low speed.

The problem has been solved by the provision of a device known as a "Decelakron." It comprises a weight which is mounted on anti-friction bearings and restrained by a spring. When the brakes are applied, the inertia of the weight tends to cause it to move relative to the car, but ordinarily it is prevented from moving by the spring. If the deceleration is sufficiently rapid, however, the inertia force on the weight overcomes the spring pressure and the resulting motion of the weight is caused to release the brake and thus to limit the rate of retardation.

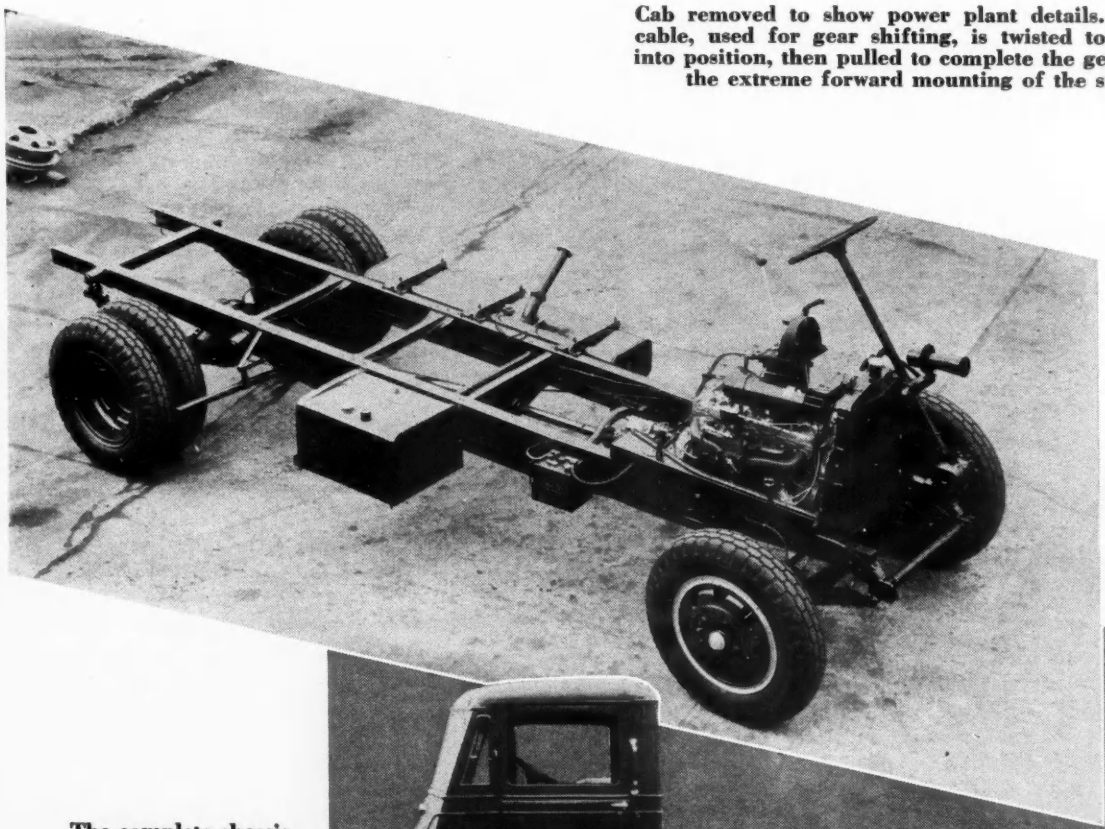
REO

Cab-Over-Engine Metropolitan Chassis

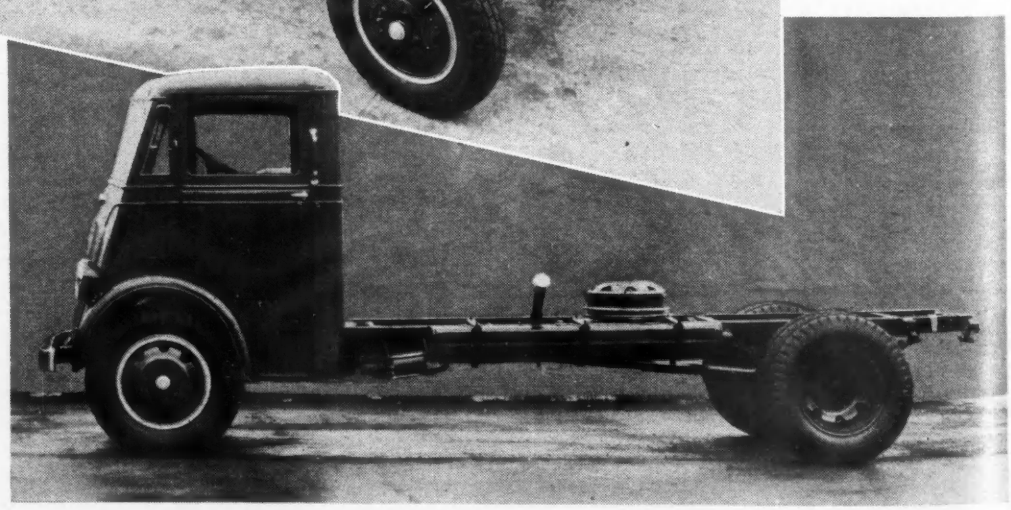


Three views of the Reo Metropolitan chassis for cab-over-engine mounting. A full description of the Reo 2D4M line appeared in *Automotive Industries*, February 22, on page 320.

Cowling in place which provides insulation for the cab. Each of its three sections consists of a layer of asbestos sandwiched between two metal sheets.



Cab removed to show power plant details. The heavy flexible cable, used for gear shifting, is twisted to move shifter forks into position, then pulled to complete the gear change. Note also the extreme forward mounting of the steering column.



The complete chassis with Reo cab in place.

The Horizons of Business

by Joseph Stagg Lawrence

Stock Market Jitters

THE market is currently undergoing one of its periodic sinking spells. The "Street" is distinctly nervous. Statisticians and brokers are anxiously discussing prices, the factors which may possibly account for their weakness, and the prospect. Even though the tangible foundations of business disclose no serious weakness, the fact that the market is apprehensive is a matter of some concern.

In the first place, mass emotions play an important and at times, possibly, a controlling role in the business situation. In the fields of banking, security markets and capital goods, the purely psychic condition of the principals often accounts for decisions which have a vital bearing upon business.

Banking

Consider banking. The act of granting credit is a highly qualitative function. It is impractical to establish a mechanical formula which relieves the credit officer of the responsibility in making a decision. Judgment must always play a part. The granting of credit is an expression of faith in the individual or organization which is to employ it. It is based upon a conviction that its use will be profitable, and that the obligation will be retired upon maturity. This calls for confidence in the future, and the future which at one moment seems comforting to the banker may at another seem distinctly disturbing. These contrasting responses to what may physically be the same set of circumstances cannot be explained logically and never have been explained by psychologists or by the myriad seers of less authentic knowledge.

Security Values

The security market offers similarly baffling problems in valuation. A certain stock on one day sells at 121 and some days later at 106, although in the interval nothing has changed the ultimate earnings prospects of the company which would warrant such a decline. The price of a stock is the product of two intangibles: the future earnings of the company, which mortal man cannot ascertain, and the rate at which those earnings may be discounted, which similarly defies current determination. Obviously the weight of these two factors depends altogether upon how the individual feels. The tendency to place an unfavorable construction upon the facts as well as the opposite tendency to view the facts favorably, pessimism and optimism for short, are both contagious. As one practical investment executive stated after studying the statistical record, "I don't see how anyone can be bearish with this business situation, but the trouble is that if enough people feel that way about the market they can create the condition which they fear."

Capital Goods

Add to these the frame of mind of the individual or organization which contemplates the expenditure of funds for capital purposes. A locomotive or an addition to the plant need not be started today. It can be postponed a day, a month, a year. If fear assails those who "have more than ten dollars" so that they defer the construction of capital goods, production may once more take a tailspin. There are no laws against this.

The Cause of Improvement

We can do better than theorize about these matters. The rise in the stock market during the past year has been a factor in the improvement of business. During that period the value of common and preferred stock listed on the New York Stock Exchange has increased 22 billion dollars. No one knows how much this has helped the large volume of new financing, the boom pace of the machine tool industry, the gratifying recovery in construction, the active assembly lines in Detroit. It will get us nowhere to say that business activity comes first and the stock market afterward. Such a causal sequence cannot be demonstrated. Logic will support the proposition that the stock market brings prosperity as much as it will support the reverse thesis. However the sequence runs, a loss of several billions in the value of listed securities will make the owners feel that much poorer and is a factor with which to reckon.

The conceit of the human animal is such that he will not openly admit the force of a power which cannot be seen, measured or assayed by the rules of material evidence. Every action, whatever its true cause, must invoke some reason which can qualify in court.

Sun Spots?

It would never do, for example, to say that a reaction has started in the stock market because the ultra violet rays emitted by the sun have lost some of that magnetic quality which may or may not account for mass optimism. We do not suggest that this is a valid explanation. We say only that if the real reason for changing mass moods were so insubstantial as a shift in the spots on the sun, it would be a terrible blow to men's ego and sadly undermine their self-respect. The search for a reason is dictated by this ego and may have nothing at all to do with the effect.

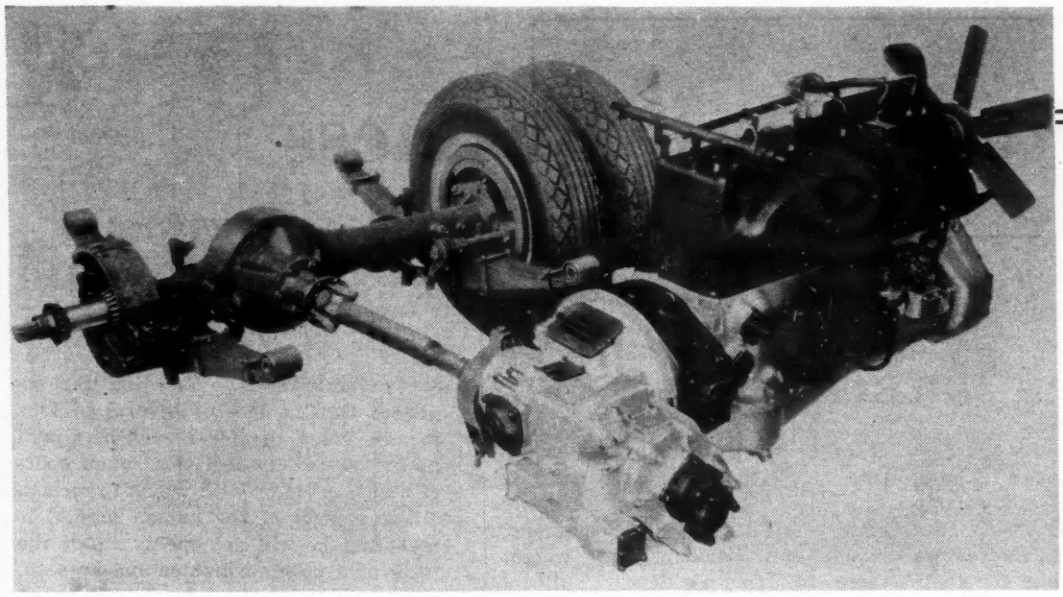
At present the security market is confronted by an effect. This, the market demands, must be explained by something other than supernatural or metaphysical causes. What then are these rational scapegoats to which the market attributes its weakness?

The Count

The first is the imminent collapse of the European gold bloc. This, it is averred, will be deflationary and the market being a composite of highly astute traders is discounting the effects in advance. If pressed the reasoning proceeds as follows: There is in this country 5000 million, 1500 million or 1000 million dollars (take your choice) of French money, mostly in securities. If France abandons gold some substantial portion of this will pack up and go home. This will be accomplished by dumping securities to realize cash. Hence the market weakness in anticipation.

The second is the technical condition

(*Turn to page 615, please*)

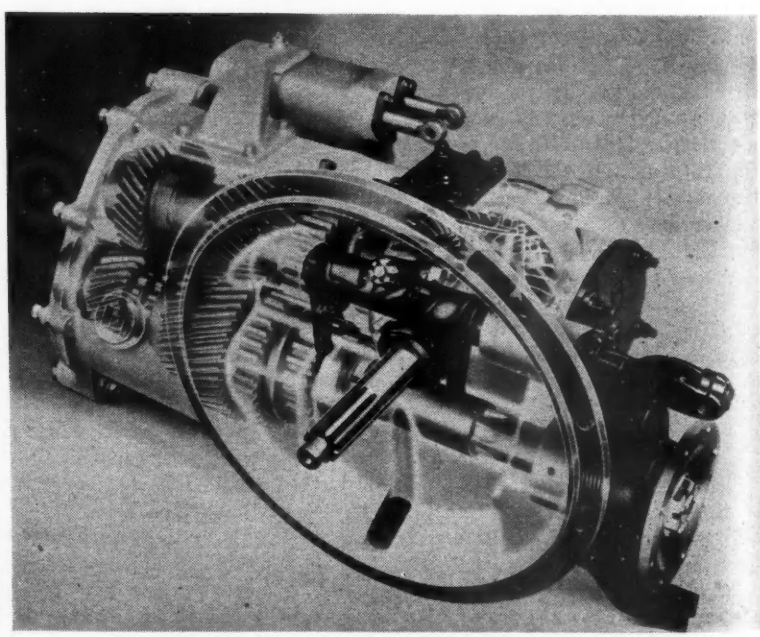


Rear axle and powerplant of Mack rear-engined bus

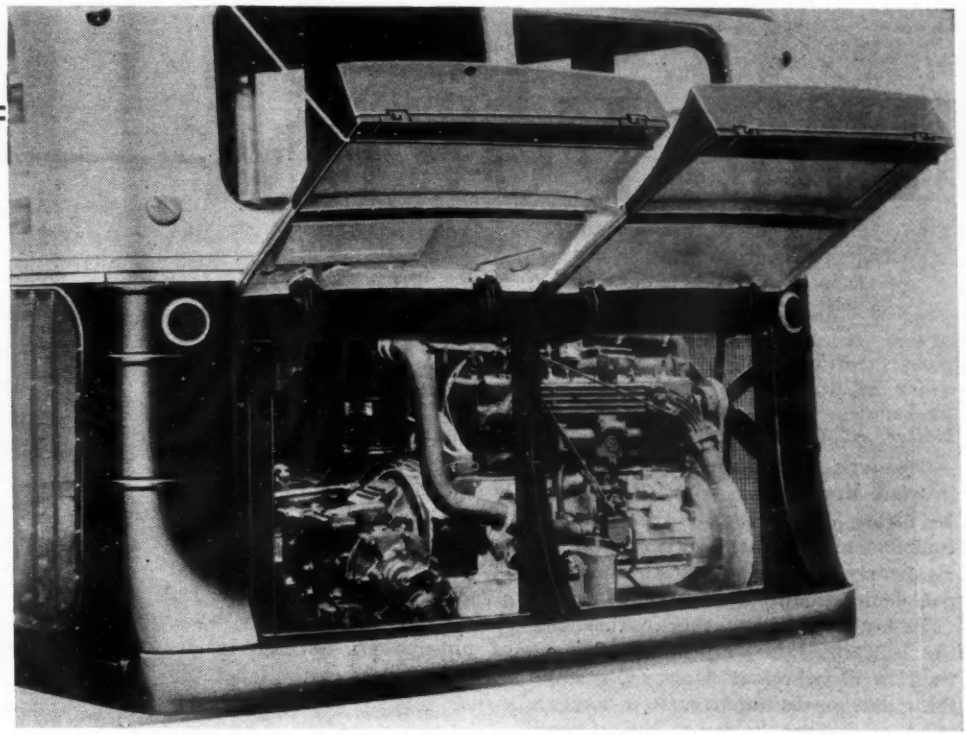
Mack Buses with

THREE rear-engined bus models are at present being offered by Mack Trucks, Inc., New York. All of them naturally are of the transit type, the bus body overhanging the wheelbase a considerable distance at both front and rear. By placing the engine transversely under the wide rear seat, space is economized to the utmost, and the greatest seating capacity obtained for a given length of wheelbase. The Model CT is a 35-passenger bus and is equipped with a six-cylinder engine of 525-cu. in. displacement; Model CQ is a 30-passenger bus with a 468-cu. in. engine. In both of these models the seats are 34 in. wide, spaced 30 in., and there is an aisle 21 in. wide. Model CW seats 20 passengers and is equipped with an engine of 310 cu. in. displacement. It seats four abreast on 34-in. seats on 30-in. centers with an 18-in. aisle.

The novel features of these buses are in the arrangement of the engine and its accessories and of the transmission and drive. The engines are the standard Mack bus engines which have been used on buses with front-mounted powerplants for a number of years. All are of the six-cylinder vertical type and are arranged under the wide transverse rear seat, with the "distribution" end close to the right side of the bus. The engine compartment is completely enclosed at front and rear, on top and bottom, and it forms an air tunnel through which air is



Phantom view of Mack three-speed-and-reverse bus transmission



Showing accessibility of rear-mounted powerplant

Rear Engines

economize space. Through the novel arrangement of engine, transmission and accessories mechanical adjustments are easily made.

blown by the cooling fan. Air enters the tunnel through a circular screened opening at the right, passes through the radiator on the left and leaves through a rectangular screened opening in the left side of the compartment. There are two large openings in the rear of the engine compartment, for access to the engine, which are closed by doors with gaskets, so that no dust can get into the compartment through the joints of these doors, and the bottom is completely closed by an oil-tight pan.

Cooling is no doubt facilitated by the fact that the heat absorbed by the air in passing through the radiator core is immediately discharged and is not carried into the compartment of the engine.

A phantom view of the transmission is reproduced herewith and clearly shows the general arrangement of the transmission and drive unit. The transmission housing is provided with a large circular flange on one side by which it bolts to the flywheel housing of the engine. The clutch shaft extends into the transmission housing from the side and connects by a pair of spiral bevel gears to the upper one of the two transmission shafts, which latter extend in the fore and aft direction relative to the chassis. Three forward speeds are furnished by the transmission, all obtained by means of constant-mesh helical gears which are engaged by means of gear-type clutches. For each of these speeds the power is transmitted by one pair of gears from the upper to the lower shaft in the transmission housing. The reverse speed is obtained by means of sliding gears at the forward end of the housing.

From the lower of the two transmission shafts the power is transmitted to the rear axle by a short propeller shaft with needle-bearing universal joints. The so-called center housing of the rear axle is not exactly in the center, but toward the left.

A transmission brake is mounted forward of the transmission.

One of the advantages claimed for these rear-engined buses is ease of access to the vital parts of the powerplants. By removing four doors, two on the sides of the engine compartment and two in the rear, all of these parts can be very conveniently reached. The two side doors, which are screened, are hinged at their front sides, while the two doors in the rear are hinged at the top. The entire powerplant may be dropped through the bottom by removing the subframe which encircles it on three sides.

Control of the clutch, transmission and transmission brake is by means of mechanical linkages, the arrangement of the controls being the conventional one, with the lever for the emergency brake to the left of the driver's seat.

The FORUM

The Octane Puzzle

Editor, AUTOMOTIVE INDUSTRIES:

The writer is sufficiently interested in your article, viz., WANTED: SOLUTION TO OCTANE PUZZLE, to comment after a fashion that is backed by nearly twenty years of retailing petroleum products.

To my mind, all of this confusion is the bastard child of present methods used in distribution. How could anything but confusion prevail if anyone tried to reasonably digest the various claims made in advertising programs? How silly to believe that the user could decide either a better or worse condition when he unknowingly buys the same product from one to six or more different brands? What qualifies the average motorist to pass decision on the merits of petroleum products? His knowledge is limited and concerns "start," "pep," "knock" or "mileage per gallon"—the most common terms of the refiner's technique are but a meaningless part of his vocabulary. Why burden him with terms such as "octane" or any other expression that would throw his conception into a tail spin. Every one of us agrees that some kind of cooperation should be inaugurated that would reduce this "hodgepodge" to a buying denominator that every motorist could understand. Connect that understanding with his requirements and warning bulletins would be unnecessary.

In the final analysis, there is only one viewpoint that any buyer will take and that is—HE WANTS WHAT HE PAYS FOR. He discredits phraseology that is an enigma to him. Permit him to recognize values in the most simple possible manner. I, therefore, suggest that motor fuels and lubricants be graded and sold as to their specification. Put some teeth into such an act. Then the motorist would have the same purchasing assurance that he obtains from the pure food laws. Rate these values in terms that he easily understands. Post gas pumps as Grade "A," "B," or "C," likewise, your lubricant containers. The motorist would then know what he was paying for and automatically assumes all of the responsibility. It would muzzle your "cat and dog" outlets, stabilize your price structure and relieve the stigma from every honest retailer that merchandise had to be sealed for the consumer's protection. Dole 1, Dole 2, or Dole 3 tells the purchaser what quality of pineapple is on the inside of the can, regardless of the label. Such simplicity is not only effective in determining value, but practical in so far as it lessens sales resistance. Possibly the great wrong with this simple mode of petroleum product marketing would be its interference with present modes (deceptive?). Certainly, it should be easy for the motor manufacturer to define the character of fuel and lubricants to be used in his product.

What you call a problem, I call simple. I may be called a fool for being a taker, but this much experience has taught me, that "horse sense" and honorable practice are seldom found in the same basket.

B. C. MEARS.

Two Stroke vs. Four-Stroke Diesels

Editor, AUTOMOTIVE INDUSTRIES:

There has been considerable discussion of the relative advantages of the two types of engine, and I wish to add here a few more points and ideas on the subject, particularly with a view to automotive and railroad Diesel engines. In this review, which was inspired by Mr. De Juhasz's article, I will refer to the two-stroke as the T- and to the four-stroke as the F-engine.

First of all, I want to mention the sensational performance of the Sulzer double-acting T-engine of about 30 in. bore and 47 in. stroke, which, when running at 152 r.p.m. developed a b.m.e.p. of 88 lb. per sq. in., delivering 2080 hp. per cylinder.

The chief point in favor of the T-engine is that for the same r.p.m., the number of power strokes is doubled. A point of less importance, is the fact that connecting-rod stresses due to gas pressure are always in one direction and that there are no gas-pressure stresses on the bolts of the crankpin bearing.

Duplication of the number of power strokes will give the T-engine the advantage over the F-engine only if the product of piston speed and b.m.e.p. is more than one-half that in the F-engine.

In European railroad engines, the piston speed of F-engines attains 1950 ft. per m., while that of the T-engine attains only 75 per cent of this figure. The b.m.e.p. is usually 50 per cent higher in the F-engine, and with turbocharged engines, a b.m.e.p. of 140 lb. per sq. in. has been obtained for short periods while starting the train.

In T-engines of 8-in. bore, a b.m.e.p. of 85 lb. per sq. in. can be obtained only by very careful design of the scavenging system and by cooling the piston by spraying crankcase oil against it. The r.p.m. is limited to 750, which corresponds to a piston speed of 1250 ft. per m.

The latest European 12- to 16-cylinder, 500-hp. F-engines are running up to 1600 r.p.m. and when turbocharged are giving a b.m.e.p. of 140 lb. per sq. in. for short periods. The above figures give a piston speed-b.m.e.p. product of 127,600 for the T-engine, with 20 per cent overload, and 280,000 for the F-engine, which is more than twice the former figure.

The F-engine is undergoing a strong development in European countries; piston speeds of 2500 ft. per min. are being used experimentally in long-stroke engines, and it is reported that temporary overloads of 100 per cent can be carried with the aid of a turbo compressor.

Additional advantages of the F-engine are as follows:

Absence of interruptions in the cylinder wall which results in more effi-

cient cooling and lubrication of piston and rings.

An induction stroke providing more time for piston cooling and lubrication and also more time for cooling of the exhaust valve.

The use of an exhaust-driven turbo supercharger which increases the output 100 per cent and decreases the specific consumption 10 per cent.

A quieter exhaust and less sensitiveness to back pressure in the exhaust line.

There is no difference between the mechanical equipments of the two types, except that the blower in the T-engine is mechanically driven and that the camshaft of this engine is driven at crankshaft speed.

HUGO K. MOREN.

Suggests Visibility Test

Editor, AUTOMOTIVE INDUSTRIES:

It would seem that with nearly a half million people killed and over ten million hurt in the last ten year, it is about time automobile designers give heed to an added improvement to decrease this toll.

I believe one cause of increasing accidents is the poor visibility of the new models of cars and suggest the following test:

Let us find a level area, about 50 ft. by 100 ft., and on one short side of area put in a pit, so that car's front hub caps are put on this line. The rear end can be lowered to level, 10 per cent grade and 20 per cent grade. Now the level area must be marked with tennis tape into 1 ft. squares; now we are ready to test a car.

We put a driver of about 5 ft. 6 in. stature in the driver's seat. Let him indicate to an attendant, the number of squares he can see at level, 10 per cent grade and 20 per cent grade. Add the three scores together; this giving each car a certain score of visibility.

I would compare these scores with accident experience.

There must be unpublished data from car manufacturers or insurance people that could be checked to see if safety is not in direct ratio with visibility.

I believe if we had had the brakes of today on the cars of fifteen years ago, there would be a lot more people alive today. Or if the visibility of a 1915 Ford were on all cars today, there would be fewer accidents. Also, if the radiators of all cars were lowered six or eight inches, we would be much safer. A puddle of water on a rainy night looks the same whether it is one inch or ten inches deep and the longer you can see it as it passes under the car the easier it is to avoid it. This applies also to children and dogs as they come out from between cars parked close to the curbs.

WM. C. HOYT,
Secretary, Clarkson and Ford Co., New York.

Cylinder and Piston Wear

Editor, AUTOMOTIVE INDUSTRIES:

At the last annual meeting of the Society of Automotive Engineers, there were a number of important and interesting papers read and discussed on the subject of cylinder and piston wear.

The consensus of opinion of the authors of these various papers was that although certain factors of design, construction, and material, have more or less definite effect on cylinder wear and ring operation, yet there were the causes unknown, which produce conditions of abrasion, which could not be foreseen.

Although the discussion centered principally on lubrication and finish, of the surfaces, very little was said as to the effect of distortion, which to me seemed to be a matter of paramount importance.

In opening the discussion, I suggested that the one "mysterious" factor was probably distortion and that in other types of engines than those immediately under consideration, distortion was of extreme significance, in its effect upon the satisfactory operation of the finished product. I also stated that in certain constructions, where cylinder bores had other parts mounted upon them, the effect of tightening up the nuts, was such that in many cases a cylinder, as mounted on the engine, had entirely lost its original true form.

(*Turn to page 615, please*)

Optimum Operating Speeds

Editor, AUTOMOTIVE INDUSTRIES:

The following paragraph appears in your abstract (Page 794, December 14, 1935, issue) of my presentation of my paper on the Rating of Aircraft Engines delivered December 5, at the American Society of Mechanical Engineers:

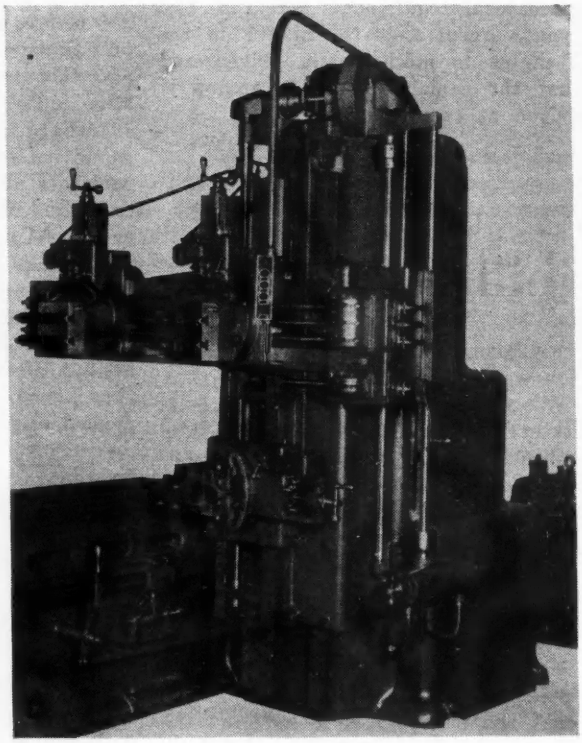
"In order to insure long operating periods between overhauls, engines are cruised at 75 per cent of full load or less. It is desirable to obtain this power at as low a crankshaft speed as possible, as a lower speed assures a lower cylinder temperature and better lubrication. Experience has shown that if the cruising power is obtained at less than the normal rated speed, the engines are in better condition at the time of overhaul."

The paragraph is incorrect, in that I emphasized, during the talk and in the paper, the dangers of operating at low crankshaft speeds. It has been proven desirable to operate at higher than normal crankshaft speeds while obtaining the same power as at the lower speed. The higher the speed in proportion to the power with a given type of engine, the lower the b.m.e.p. This results in lower cylinder temperatures and better lubrication together with longer life between overhauls, provided the internal mechanical operating conditions of the engine are satisfactory for the increased speed.

GAYLORD W. NEWTON,
Engineer in charge of Powerplants Branch, Manufacturing Inspection Service.

NEW DEVELOPMENTS

Automotive Parts, Accessories and Production Tools



Controls on Rockford planer

Hydraulic Operation For Planer

The application of hydraulic power for reciprocating a machine table is said to have certain advantages such as providing a smooth, steady cutting stroke, easily adjusted to any desired rate. Also the rapid return-rate of the table is constant, regardless of the cutting speed employed. These are some of the reasons given by The Rockford Machine Tool Co., Rockford, Ill., for employing hydraulic operation in the new planer illustrated. Hydraulic pressure is also employed for feeding all heads.

The controls on this machine have been centralized as shown. The three levers at the right provide complete control for the power-operated movements of both rail-heads including feed or rapid traverse to left or right, up or down, separately or in unison. Duplicate controls on opposite sides of the planer are provided for starting, stopping and reversing the table movement.

This machine can be supplied with a table length of 12 to 22 feet.

Rockford Has New Horizontal Drilling Machine

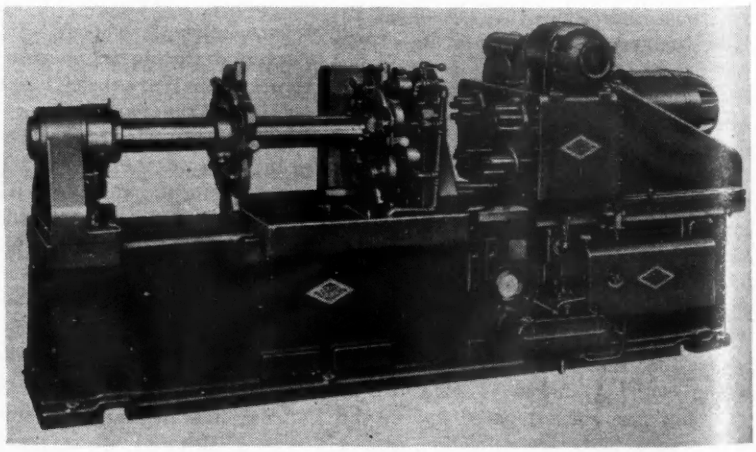
The Rockford horizontal drilling machine illustrated is equipped with a five-station fixture and tooling for drilling and tapping holes in the flange of a large crankshaft, and for milling out the center of the flange. Mounted on the right-hand end of the bed is a travelling head having an automatic hydraulic cycle of rapid approach, feed, dwell for fine finish on milling and countersinking, rapid return and stop. A central push button station provides the operator with complete control of the machine and enables him to stop it instantly at any point in its cycle.

The head has one main motor, a second motor being provided for driving the group of tapping spindles independently. Upon completion of the tapping operation this motor reverses automatically. The detachable plate on the front of the head contains 23 spindles arranged in four clusters, providing for many different kinds of work. The two work-holding heads are mounted on a heavy central shaft that rotates in anti-friction bearings for easy indexing, a large mechanically operated guide-bar locking the fixture securely in position during machining.

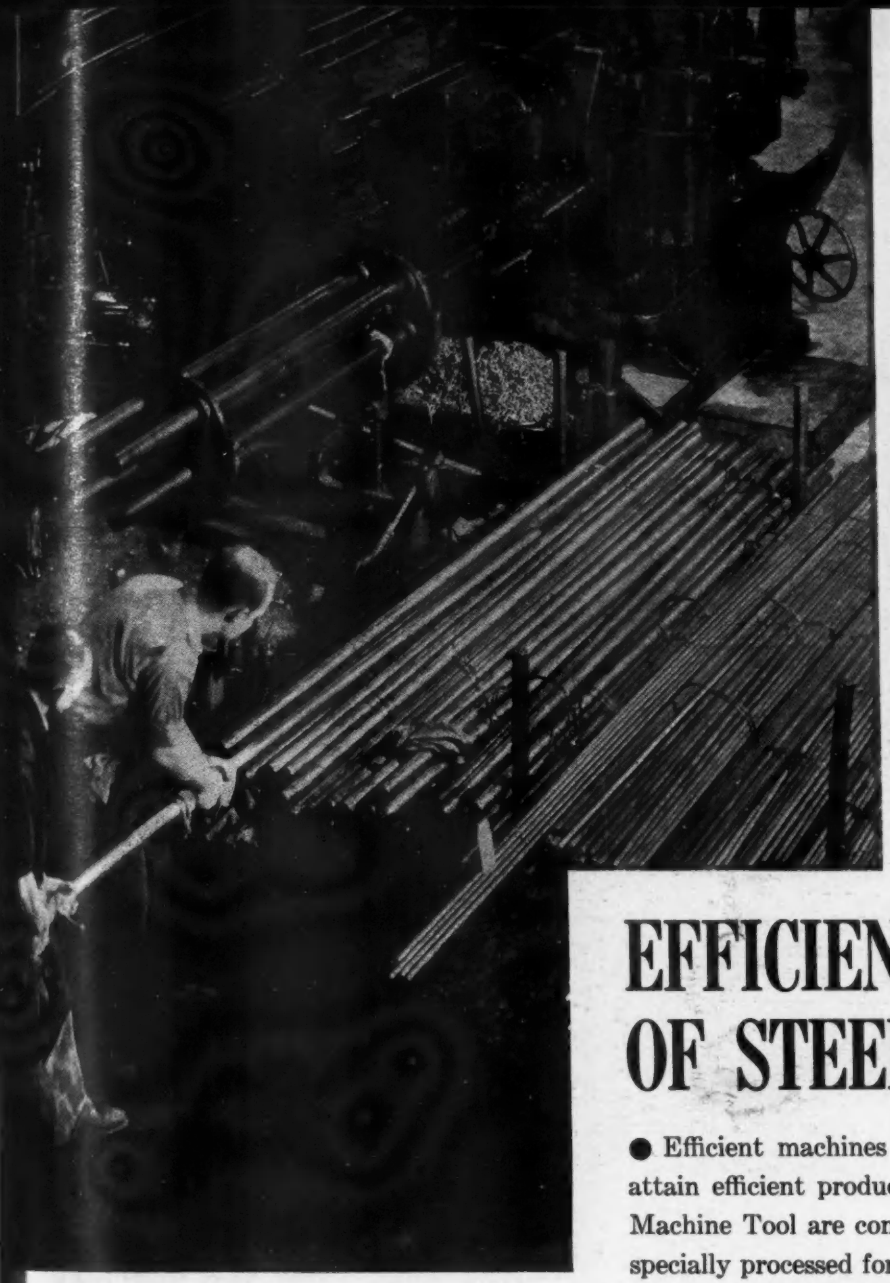
The Rockford Drilling Machine Co. is located at Rockford, Ill.

Czechoslovakia Sells Fewer Cars in 1935

During the first 11 months of 1935 a total of 8800 cars were sold in Czechoslovakia, a reduction of 4 per cent from the same period of the previous year. Among the cars sold in 1935 were 2222 Tatras, 1785 Skodas, 1888 Pragas, 801 Teros, 612 Zetkas, 405 Walters, 301 Jawas and 50 Wikows.



Drilling machine hydraulically controlled



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Union Drawn does not recommend a steel with cutting properties beyond those of which you can take full advantage. We want to suit the steel to the speed of your equipment and the needs of your finished work with the object of advancing your production efficiency.

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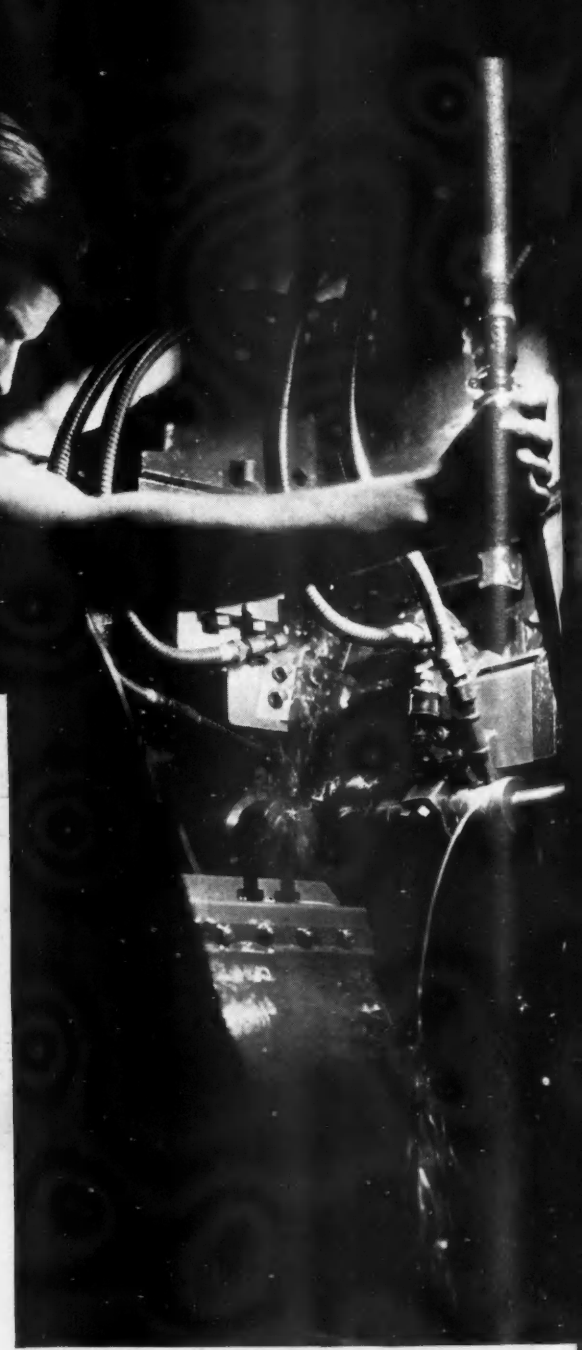

When this operator was given Union Free Cut, he reduced his tool grindings and tool changes, lowered his tool cost, increased his output and improved the finish on the parts.

IS GIVING FASTER, BETTER PRODUCTION OF MACHINED PARTS

● Reports that Union Free Cut extends the life of tools, speeds up machining production and develops an improved finish are constantly coming to us through enthusiastic verbal and written statements of users.

Such phrases as "double tool life," "less breakage of taps," "superior finish," "more surface feet per minute," "longer drill life," "less trouble with forming and cut-off tools," "fewer tool grindings" and "easy on tools" indicate that machining practice has reached a new high standard of efficiency.

Union Free Cut marks a long step forward in the quality of machining steels through removal of abrasive elements which have always been a source of rapid tool wear.

Don't fail to get your share of the increased profits now being made through lower tool expense, less down-time for grinding and tool changes and more rapid output.

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Union Cold Drawn Steels

The Horizons of Business

(Continued from page 607)

of the market itself. The rise in margin requirements, the restriction upon floor trading, the virtual prohibition of short selling, the penalties on "inside" speculation, the tabu on pools, the capital gains tax, all remove potential trading from the market and make it "thin." The example is cited of a broker who tried to sell some U. S. Steel, hit an air pocket in the market and got no bid for several hours. Two hundred millions of securities dumped on a market like that would demoralize it.

The third reason for market anemia is the coming election. This we have already discussed in these pages as a business factor. The point is that this is not an ordinary election to confirm the present White House occupant or install a new one. It involves the form of American government and the existence of American institutions. As the day for the "solemn referendum" on this issue approaches business is bound to experience the chill of uncertainty.

Do the portents offer any hope? We shall study the stars and read the message next week.

The Forum

(Continued from page 611)

C. M. Larson, in reply to my remarks, stated that he did not think that one engine in a hundred thousand suffered from distortion.

On Mr. Larson's own showing in his paper, it is stated that "cylinder distortion was a factor which had a pronounced effect on wear and that comparative tests became meaningless if head bolts were not tightened to the same tension for all tests."

This remark entirely refutes his contention that cylinder distortion did not attain significance.

In further support of my suggestion, I would refer to a slide which was shown by S. W. Sparrow of the Studebaker Corporation which illustrated a piston, one of many that had suffered under test. This piston showed a dry spot about the center of the skirt and to the side of the piston pin, which he stated was characteristic of pistons put in a certain cylinder on that particular engine.

He stated that by a change in the water jacket, this difficulty was entirely removed.

We know perfectly well that early engines in which the careful design was not incorporated in the water jacket, heat flow did very definitely cause distortion, and we cannot now say that design and construction is so perfected that these conditions no longer apply.

It would be interesting to have views of others upon this most important subject.

ROBERT W. A. BREWER.

AN engineering bulletin on Oil Sludge has been issued by the Automotive Engineering Division, Lubricating Department, Socony-Vacuum Oil Co., Inc. It explains that oil sludge as found in internal-combustion engines consists of finely divided solid matter, such as carbon due to the combustion, road dust drawn in through the carburetor or breather, and fine metal particles worn from the bearings, rings and cylinder walls, all held together by a binder which is formed by the oxidation of unstable elements in the oil. The rate at which sludge is formed in an engine in operation depends on the degree to which these unstable elements have been removed from the oil in the refining process.

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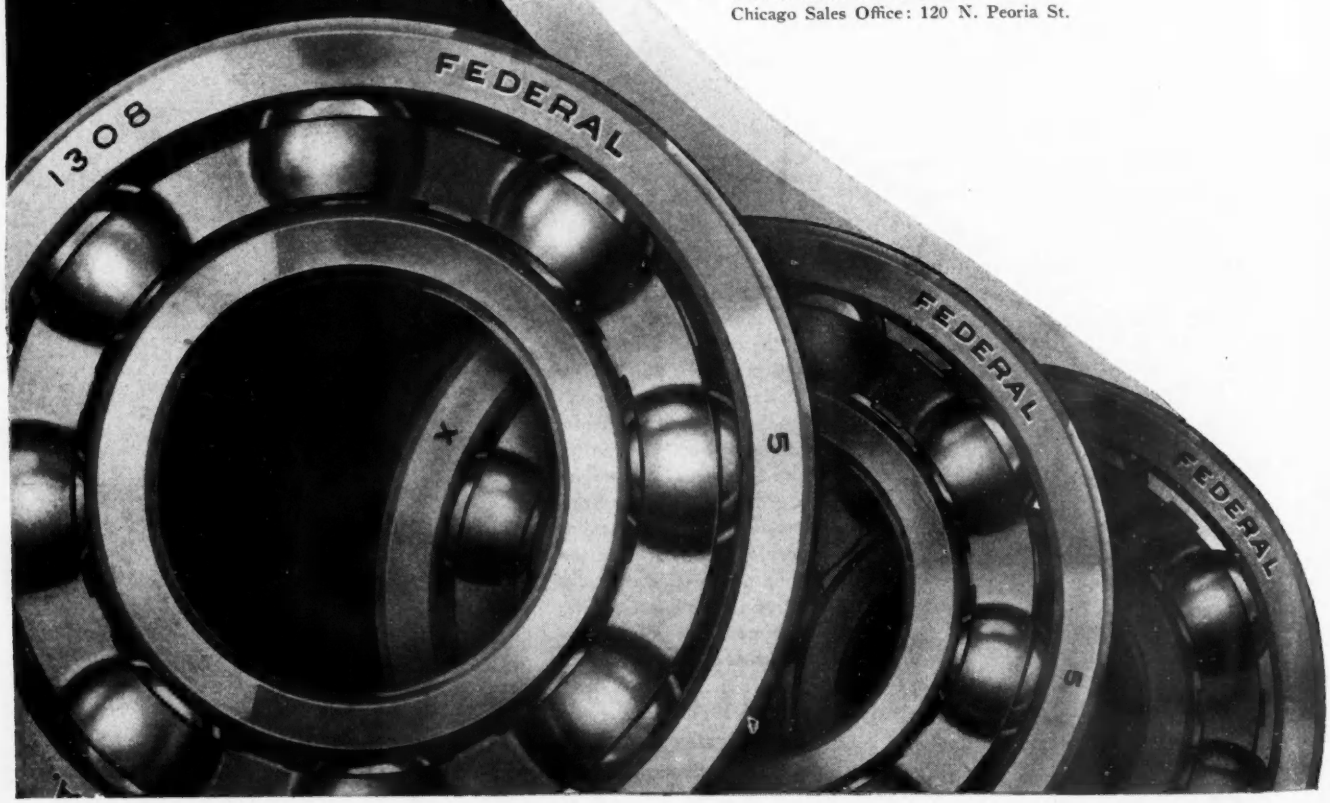
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